PROCEEDINGS OF
THE SEMINAR ON

PRESENT STATUS OF PRAWN FARMING IN INDIA

BHUBANESWAR, 8-9, MAY, 1985

Organised by
The Marine Products Export Development Authority
In association with
State Bank of India, Orissa Circle, Bhubaneswar.

THE MARINE PRODUCTS EXPORT DEVELOPMENT AUTHORITY
M. G. ROAD, COCHIN 682016, KERALA, INDIA

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Edited by:

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and

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FOREWORD

The National Seminar on the Present Status of Prawn Farming in India was organised by the Marine Products Export Development Authority (MPEDA) in association with the State Bank of India, Orissa Circle in Bhubaneswar in May 1985 with a view to taking stock of the status of development of prawn farming in India, identifying the constraints and evolving a plan of action. The leading research and development institutions participated in the Seminar and presented papers on the technology a vailable in India on coastal aquaculture engineerng, farm management, hatchery production of seed and related topics. Representatives of the Department of Fisheries from the Maritime States presented status papers concerning their respective States.

This volume containing the papers presented at the Seminar bring out the current status of the technology in various aspects of prawn farming and also the development of prawn farming in the Maritime States. The recommendations of the Seminar, it is hoped, would lead to positive steps for the development of prawn farming in the country.

We are grateful to Miss Freda Topno, Hon'ble Minister of State for Fisheries, Government of Orissa, Shri V C Pande, formerly Additional Secretary, Ministry of Commerce and Dr K K Kanungo, Adviser, Planning Commission for their valuable participation in the Seminar and for their wholehearted co-operation in organising it successfully.

Our Joint Director in-charge of Prawn Farming, Dr. M Sakthivel and our Officers in the Prawn Farming Division put in considerable efforts in organising the Seminar and for bringing out this publication, which, I hope, would be of interest to all concerned with brackishwater prawn farming in the country.

Sd/-
(T K A NAIR)
Chairman

March 3, 1986

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Inaugural Session

PRESIDENTIAL ADDRESS

By

MISS FREDO TOPNO

Hon'ble Minister of State for Fisheries and Animal Husbandary
Govt. of Orissa.

Friends,

It is my proud privilege and pleasure to welcome you all to this National Seminar on "The Present Status of Prawn Farming in India", organised by the Marine Products Export Development Authority and the State Bank of India, Bhubaneswar today the 8th May, 1985, at Bhubaneswar, the famous temple city of Orissa.

Seminars and Conferences have always added richly to the limited dimension of our existing knowledge on matters that concren human well being.

Aquaculture has now been recognised as an important means for improving the rural economy to a large extent in a country like India, where over 50% of the population live below poverty line. In the recent past, the fresh water aquaculture has made a distinct headway in the country and generated interest among the rural mass, to accept fish culture as an important source of income.

In the coastal region of the country, the scope for fish culture is limited. The vast potential of Brackish water resources in the regions have hitherto been either neglected or under exploited. Such brackish water areas are very much sutiable for production of exportable prawns through farming practices.

It is, therefore, imperative to make sincere endeavour for development of brackish water resources, which would not only lead to additional production of valuable prawn for export market, but also to provide ample scope for gainful employment to a larger section of rural mass.

As you know, Orissa is a maritime state having a coast line of 480 kms. Out of the vast brackish water resources of the State, about 17,000 hectares have been surveyed and found suitable for development by the Department of Fisheries.

It is estimated that if this extent of potential resources of the State could be brought under prawn farming, the production would increase to about 4,500 tonnes of valuable prawn valued at Rs. 27 crores.

The Chilka lake, which is the largest brackish water lagoon in the country, spreading over 1,165 square kilometers

is well known for better recruitemnt and growth of prawns. About 1,500 tonnes of prawn are annually harvested from the lake. The most suitable brackish water areas, estimated over 5,000 hectares are available in the periphery of the lake for development of prawn farming. The natural fertility of its soil together with other conducive ecological conditions offer the best scope for development of prawn farming.

In order to develop prawn farming in the State, two special agencies have been set up in 1983, in the coastal districts of Cuttack, Puri, Ganjam and Balasore. During the Seventh Five Year Plan, there is a programme to set up one such agency in each of these districts. Of late, prawn farming has been recognised as one of the most dependable anti-poverty programme. Prawn can be termed as 'living dollar' for the poor man. So far, 250 hectares of brackish water ponds have been developed through 100% Government assistance to rehabilitate 1,000 poor families. Each family is allotted with a 0.20 hectare pond. The average income per family is reported to be around Rs. 2400/- from prawn culture per crop, which is one of the highest among all the antipoverty programmes implemented in the State. In the private sector also, about 223 hectares have been developed through bank finance and individual resources. A massive programme has been drawn for development of prawn farming in 4,000 hectares of brackish water areas in the State during the Seventh Five-Year Plan period.

Prawn farming, being a sophisticated technology and capital intensive in nature, calls for collective effort and assistance of Central and State Governments, Scientists, financing institutions and developmental agencies.

I understand that the Marine Products Export Development Authority has shouldered the responsibility of developing prawn farming in the country, by establishing their Regional Centres mostly in the maritime States and for providing technical, financial and extension support. Let me hope that the assistance of all kinds from M P E D A will be made available to our State, so that along with development of hitherto unexploited valuable resources, benefits will flow to the people of the State.

I hope that the deliberations of this seminar during its 2 - day valuable and fruitful sessions, will result in definite and positive action for strategic development of prawn farming and transfer of technology to the rural mass, with the objective of improving the socio-economic condition of the weaker sections, which is the call of the Nation today.

"JAIHIND"

INAUGURAL ADDRESS

By

SHRI KIRANMOY NANDA

Hon'ble Minister - in - Charge for Fisheries
Govt. of West Bengal.

As all of you are well aware, SHRIMP is one of the most important products entering the world trade in fisheries. It provides a source of foreign exchange for exporting countries. Current international trade in shrimp is of the order of about US$ 3 billion and this trade appears to grow further, though at a relatively slow rate.

World shrimp landings have reached 1.77 million tonnes (live weight) in 1983, India's share being 10 per cent of the total. Although there have been fluctuations in the catches of individual countries, world shrimp production has remained relatively stable since 1977 and further overall growth in landings is not considered likely. Further investment in capture fisheries should be considered in the light of limited additional shrimp resources susceptible to exploitation and such operations are vulnerable to increase in cost, especially of fuel.

India has remained the number one shrimp producer in the world for the last ten years. India has achieved a growth of 100 per cent increase in the ten year period from 1970 to 1980, from a level of 1,22,000 tonnes to 2,44,000 tonnes. However, the production has stagnated in the last five years and the production in 1983 is only 2,07,258 tonnes. It is expected that if fishing effort is intensified in certain areas of our coast, possible depletion of resources is likely to take place. Economic factors such as cost of fuel have risen in recent years and have caused boats to idle, with consequent losses in production. Over-investment in boats in some areas has caused the catch per unit effort to drop to uneconomic levels of operation.

It is in this context that shrimp culture acquires greater significance. it is thought that substantial part of additional production required will have to come from shrimp culture. Aquaculture operations, as you know, are far less fuel intensive and since shrimp is frozen and packed within a few hours of harvest, consistently good quality can be obtained.

Shrimp culture is seen, therefore, on an international level, as a most likely area for investment in the fisheries sector. Extensive and semi-intensive shrimp farming have now become a commercial reality. Risks have been reduced through advances in technology and management skills. Opportunities for investment include upgrading of traditional pond operations, development of new pond areas, hatcheries and feed mills and the provision

of infrastructures required for handling, processing and marketing. Since shrimp farmers can suitably determine shrimp sizes and the timing of their harvest, production can be planned to meet the market demands required. It is envisaged that new segments of the markets can be developed as a result of the ability of the farmers to ensure continuity of supply of size required.

Brackish water shrimp farming is already an industry of significant size. It is estimated that 98,000 tonnes of farmed shrimp was produced in Asia in 1984, 82 per cent of this from the countries of South-East Asia. Production is expected to double by 1990. Unfortunately, shrimp culture in India has not yet made any impact in spite of the research efforts of Institutes under the Central and State Governments.

Of the total 1.5 million hectares of brackish water area available in the country, atleast 10 per cent of the area, i.e. 1,50,000 ha. can be considered suitable for shrimp culture. Of this, 25,000 ha. in West Bengal and 7,000 ha. in Kerala are now operational, producing, however, only 15,000 - 20,000 tonnes of prawns by traditional farming practices. These proven areas for prawn farming await technological improvement to increase the current rate of production from 200 - 400 Kg. to atleast one to two-tonnes per hectare.

In addition to this, the development of new areas should lead to 100 per cent increase in our export. Though shrimp farm extension programme has been taken up by the MPEDA since 1979, the progress in achieving the targets has not been very impressive. So far, only 1968 ha. have been developed and 1,300 tonnes produced for export. Basic infrastructure, regular supply of inputs such as seed and feed, technical manpower and commercially viable technology in farm management, seed production and coastal aquaculture engineering are stated to be other deficit areas. To overcome all these hurdles, we need a massive operation with clear targets for atleast the next two decades. Concerted effort of all the Maritime State Governments is urgently required in this direction.

The tentative target fixed for frozen shrimp for the terminal year of the Seventh Plan, viz., 1989-90 is 66,000 tonnes valued at Rs. 546.8 crores. It will be impossible to achieve this target without large-scale shrimp culture operation, undertaken by all Maritime States directly or indirectly. The purpose of this Conference, therefore, is to underline the urgent need to take up shrimp farming on a massive commercial scale. This calls for a very efficient organisational set-up to be immediately put into operation by all Maritime States concerned. I, therefore, strongly urge the senior officers of Maritime States present here to consider the subject of shrimp farming seriously and make full use of the allotments made in the Seventh Plan budget and take advantage of institutional finance available for the purpose, aggressively.

In our two major markets, viz., U.S.A. and Japan, we have started facing stiff competition from countries which have taken up shrimp farming very seriously in the last five years. For example, as all of you should be aware, we were number two in the list of exporters of

shrimp into USA, next to Mexico till 1980. After 1980, our position has been reduced to the third place and we are afraid that, we may soon move into the fourth or fifth place, if we do not augment our domestic production.

This has happened because of the large scale commercial shrimp operation launched successfully by Ecuador and Panama. Ecuador has achieved a production of 25,000 tonnes of shrimp in 1983 in a matter of 3 years, from a base level of negligible production. The same story will be repeated in the case of Panama also soon.

With regard to the Japanese market, because of the commercial shrimp farming activities by Taiwan and China, our No. 1 position is likely to be affected. Taiwan, for example, is producing 20,000 tonnes from shrimp culture alone, and their target for 1990 is 50,000 tonnes. You may think that Taiwan has achieved this by large scale ponds with sophisticated technology. Actually this is not so. The shrimp farming activity in Taiwan is conducted on a large scale as a family business with pond area of one to two ha. each. They are able to achieve average production of 5 tonnes per ha. and the maximum yield recorded is of the order of 22 tonnes per ha. per year. 1,200 commercial shrimp hatcheries are functioning as small family business in Taiwan, while we have not been able so far to put up even one commercial hatchery into operation.

These achievements are really staggering when compared with what we have so far achieved in India, in spite of so much of talk about shrimp farming in the last ten years. The spectacular success of Taiwan is attributed to a unique combination of circumstances which include ideal water supplies, suitable land, hard-working agricultural minded family business people, natural entrepreneurial spirit, successful research and extension services and significant Government encouragement.

Aquaculture engineering plays a vital role in area survey, farm construction desiltation problems, water supply and water exchange. Construction of farms without proper knowledge on this subject may lead to total loss of investment. Tidal water ingress has to be studied carefully to minimise the operation cost on water exchange. Since this subject is of recent origin, many educational institutions in India do not teach this course. I came to know that only one institution i. e. Indian Institute of Technology, Kharagpur, has started this course recently and the first batch of students are going to come out by the end of this year. We are yet to conduct a survey of large area to identify suitable sites for farm construction for dearth of aquaculture engineers. Many institutions like I. I. T. kharagpur should start this special course on civil engineering and build up sufficient technical manpower in the country.

I assure you the fullest co-operation of my Govt. for the development of shrimp farming in India. I invite the big entrepreneurs of Banking Institutions to extend the fullest co-operation for the development of prawn farming in my State. My State will give shrimp farming, top priority in the development plans, since this project is intimately and vitally related to boosting our foreign exchange earnings. With this I declare the Seminar as inaugurated.

ADDRESS

BY

SHRI S. SOLOMON RAJ

General Manager (Operations), State Bank of India, Bhubaneswar Circle.

We, in State Bank of India, consider it a privilege to be co-sponsors of this seminar and have great pleasure in welcoming the dignitaries and participants from different parts of the country. The two-day seminar, I am confident, will provide a forum for cross-fertilization of ideas of experts, owners of prawn farms and those who help in marketing the produce. The resultant synthesis will enable us to evolve realistic action plans and strategies for fostering the growth of brackishwater prawn farming in the maritime states in general, and Orissa in particular.

Brackish water prawn culture has assumed great deal of importance now a days, due to heavy demand for prawns in the foreign market, and appears to be a valuable tool available to the Government, for raising the socio-econ omic status of a large section of the rural population. Looking to the vast potential available, scope exists for Govt. agencies and financial institutions joining hands, and implementing the various schemes to speedily increase the brackish water area for scientific prawn farming, during the seventh plan period.

Financing of fishery schemes is not new to the commercial banks in India. We have been associated in a big way in financing marine fishery, inland fishery and pisciculture. While our experience with regard to recovery of loans granted for development of inland fishery in the state of Orissa is good, the recovery performance of mechanised trawler financing under the marine fishery has been none too satisfactory. We shall welcme the agencies like MPEDA to make a study into the failure in the functioning of mechanised trawlers, and suggest ways and means to make them viable units in due course.

Our bank is also financing prawn farms at Balasore and Puri Districts in co-ordination with brackish water fishery development agencies, set up by the State Government. It is too early to make an assessment of the performance of these farms, but I would like to make the following suggestions in the light of the experience so far gained:

(i) The Government's intention is to lease out a major portion of the brackish water area to E.R.R.P., poor fishermen and other weaker section of the community in

(A) catching fish, by going into the sea, and

(B) growing prawns under controlled conditions by providing healthy

environment, are two different things, and experience of the latter requiring skills in management of economic assets. The farmer should develop abiding interest in the prawn culture, and be willing to adopt modern scientific methods in farming. The financing bank and the Government development agency should also consider the project as a joint venture with the farmer and be in close touch with each other, right from the selection of site till harvesting and marketing of prawns.

(ii) The indigenous and exogenous factors influencing the development of a market structure for prawns should be studied to usher in a non-exploitative trade culture. The structural change in marketing should be reflected in the higher bargaining power of the producer as evidenced by higher share of the market price to him. I have in mind the significant structural changes that have taken place in the marketing of apples in Himachal Pradesh and selling of milk by co-operative societies in Gujarat. A socially beneficial change in the market structure will lead to the generation of investible surplus, which could be used for creation of infrastructural facilities for bulk procurement, grading, storage, processing, transportation etc.

(iii) Arising out of (i) above, it will be necessary for the loan beneficiaries from the weaker sections of the society to be exposed to the study of successful operation of prawn farming projects in the private sector.

(iv) The export houses in the public or private sector may be associated in formulating a tie-up arrangement scheme as we have in the case of sugar industry. The farmers receive technical support from the sugar factory, which also arranges through banks, supply of fertilizers and funds for working capital expenses to sugarcane growers. At the time of purchasing the sugarcane at a reasonable price. the factory deducts and directly remits to the bank, the money advanced to the farmers. A similar arrangement for prawns will not only ensure prompt payment of bank loans, but will also make available the expert guidance of the export houses in producing prawns as required by the market place.

(v) The availability of ready-mix feed at a reasonable cost should be improved.

(vi) Tidal amplitude, its fluctuations during various seasons should be carefully observed before selection of the site. The farms should be well protected from predatory fish entering the farm and eating away the juveniles, as happened in some of the farms financed by us in the Balasore District,

(vii) There should be assured supply of desired species, which would generate sufficient surplus for the farmer. Looking to the magnitude

of the development of prawn-culture envisaged in the seventh plan, adequate number of hatcheries will have to be set up to meet the demand for quality seeds. Large farms to be run on commercial lines cannot rely on natural resources for seed availability. In this connection, the efforts of the Orissa Maritime and Chilka Area Development Corporation Ltd (OMCAD) to develop prawn culture farms on modern lines in a big way and establish a hatchery, are noteworthy.

(viii) Arrangement for soil testing and maintenance of desired salinity, congenial for the growth of prawns should be made on a regular basis.

(ix) In order to keep the unit cost as low as possible, construction of permanent ring bund can be taken up, which will bring more areas under prawn farming, without the risk of being washed off during high tidal wave or flood.

(x) Easy accessibility to the farm site will have to be ensured through construction of suitable roads.

Finally unless the backward and forward linkages are properly established it will be difficult to make the scheme a success. The purpose of any enterprise is to create a customer and satisfy his needs through appropriate marketing strategies. I have laid some emphasis on the marketing aspect of prawns, and I hope that this will be deliberated upon in depth during the seminar.

We are grateful to the authorities of MPEDA for selecting Bhubaneswar as the venue for the seminar, and it is my firm belief that this seminar will be an important milestone in the development of prawn culture in India.

SUMMARY OF THE PROCEEDINGS

The seminar began at 0930 hrs on May 8, 1985 at Hotel Swasti, Bhubaneswar, Orissa State. Welcoming the distinguished guests and participants, Shri T K A Nair, Chairman, MPEDA mentioned that India was the world leader in shrimp production and export and the export trade depended on production of shrimps. Since the catches from the sea are stagnating for the last several years, further increase in production and export is possible only through shrimp farming. When compared to the progress of South East Asian and Latin American countries, India's performance in this field is not satisfactory for want of proper technology and infrastructural fecilities for commercial production.

Miss Freda Topno, Hon'ble Minister of State for Fisheries, Government of Orissa presided over the inaugural function and Shri Kiranmoy Nanda, Hon'ble Minister for Fisheries, Government of West Bengal inaugurated the seminar. Shri Salmon Raj, General Manager, SBI, Orissa Circle and Dr. Kanungo, Member Planning Commission dilivered special addresses on the occasion. Dr. M. Sakthivel Convenor of the Seminar, highlighted the achievements of Taiwan in Shrimp farming and urged the various agencies involved in shrimp farming to work together for quick progress.

Dr. Silas, Director, CMFRI, presented a "Manual on operation of shrimp hatchery" and Miss Freda Topno Minister of State for Fisheries, Govt. of Orissa released it on the occasion. While appreciating the publication, she lauded the good work done by the Scientists of CMFRI in the field of shrimp hatchery technology. Shri K Mitra, President Orissa Seafood Exporters Association appreciated the role of MPEDA in shrimp farming and proposed a vote of thanks.

First Session

This session was devoted for assessing the present status of technology in shrimp farming in India. Dr. K Kanungo Advisor, Planning Commission, chaired the session. The Rapporteurs were Dr. P U Verghese and Shri B C Behera. Dr. Kanungo in his opening remarks stressed that the small man who depended on the technology that was being developed, should be able to use it to transform his life for the better. Dr. Silas who spoke on the technology available or prawn seed production in India made a rough calculation on seed requirement and said that India would need 2,400 - 3,600 million seeds of *P. indicus* and 900-1,350 million seeds of *P. monodon*. To produce so much of seeds 58 hatcheries (40 for *P. indicus* and 18 for *P. monodon*) are required. He explained the details of work done by the Narakkal unit of CMFRI and their achievements in the technology of seed production of *P. indicus* and other species. Dr. Silas also mentioned the training programme conducted by CMFRI to impart the technology to the officials

of State Fisheries, teaching staff of the Universities and entrepreneurs.

Dr. A V Natarajan, Director, CIFRI, Barrackpore in his talk on present status of brackishwater shrimp farm management technology in India brought to light the rich potentials of West Bengal and the scope for improvement with traditional culture system for higher productivity with proper feed, selective stocking of fast growing varieties and water quality management. He said that the CIFRI was presently engaged in shrimp feed formulation to achieve a production of 2 tonnes/ ha in 3 months and the result would be known in a year or two. Dr. Natarajan said that another 30,000 ha could be added to the existing 45,000 ha which together could generate a production of 50,000 tonnes of shrimps. In addition to this, 10,000 ha could be brought under pond based semi-intensive system with a production of 25,000 tonnes. A production of 75,000 tonnes of shrimps from brackishwater aquaculture is an achievable target during the next 10 years provided sufficient effort on regular supply of inputs including extension services to farmers at field level for scientific shrimp farming is undertaken by the promotional agencies.

Cmde K M V Nair, explained the difficulties in getting the results published by the Fishery Research institutes for a common man and Dr. Kanungo requested the Directors of CMFRI and CIFRI to do the needful. He also stressed further the interaction required by the farmers and scientists to solve the day to day problem in farming.

Shri Kanakasabhapathi, Joint Director, Tamilnadu Fisheries suggested that the farmers should be supplied with PL-20 and not PL-5 to reduce the mortality of the seed. Dr. Silas replied that it would be uneconomical for any hatchery to maintain the seed upto PL-20. Dr. Sakthivel explained the need of an intermediate agency to undertake nursery rearing and steps taken by the MPEDA to set up Seed Banks for this purpose.

Shri N P Bhakta, Director, Central Institute of Coastal Engineering for Fisheries (CICEF) Banglore, stated that the subject - Coastal Aquaculture Engineering in India is still in a developing stage and the expertise developed by CICEF is yet to be tested in the field. He narrated the procedure involved in site selection and preparation of feasibility report for prawn farming. In the absence of Dr. A N Bose, Advisor, Prof. Ghosh of IIT, Kharagpur presented his paper in which the teaching programme in aquaculture Engineering was outlined. He said that the Aquaculture Engineering Course at IIT, Kharagpur prepares the students in planning, designing, contsruction, operation and maintenance of aquacultre systems in different environmental conditions. To improve the curriculam, he wanted the comments of Scientists, Engineers and Technologists and people with managerial experience.

Later, in the absence of Dr. S N Dwivedi, Director, CIFE, Bombay - his paper on Training and extension in prawn culture was presented in which the need of building technical manpower for aquaculture and the magnitude of extension work required for developing prawn farming were highlighted. This was followed by the talk of Shri T S Ramakrishnan of General Insurance Corporation

of India (GIC), Bombay. He explained the details of brackishwater prawn insurance scheme broughtout recently by GIC and quoted the assistance in the form of 50% subsidy of the Janata Personal Accident Insurance Premium given by Govt. of India for the fishermen who are members of the Fishermen's Cooperative Societies.

As Shri M C Deviah, Dy. Commissioner, Ministry of Agriculture, New Delhi, was not present, his paper on prawn farming scheme of the 7th Five Year Plan was presented on his behalf. A centrally sponsored scheme with an outlay of Rs. 100 million is to be shared equally between the Centre and the States concerned. Against the target of 1,500 ha it was possible for him to approve projects covering 400 ha as per the details given below:

Kerala	- 140 ha	- Rs. 7.2 million
West Bengal	- 80 ha	- Rs. 4.0 million
Andhra Pradesh	- 50 ha	- Rs. 2.5 million
Tamilnadu	- 50 ha	- Rs. 2.5 million
Maharashtra	- 50 ha	- Rs. 2.5 million
Orissa	- 16 ha	- Rs. 0.8 million
Hariyana	- 10 ha	- Rs. 0.6 million

The centre has also sanctioned a project for the development of 460 ha at the cost of Rs. 22 million. A target has been fixed to develop 10,000 ha during 7th Five Year Plan.

Second **Session**

The second session was chaired by Shri J. M. Girglani, Director of Fisheries, Andhra Pradesh. The rapporterurs were Shri B. Basak and Shri. V. Venkatesan This session dealt with the present status of prawn farming in various States. The papers that were presented were by Shri A. K. Luke (Gujarat), Shri S. S. Naik (Maharashtra), Shri R. M. Dhawan (Goa, Daman & Diu), Shri R. N. Shastri (Karnataka) Shri R. C. Choudhury, (Kerala), Shri M. V. Natarajan (Tamilnadu) and Shri J. M. Girglani (Andhra Pradesh).

Third Session

The third session which continued on the next day i. e. May 9, 1985 also dealt with the status papers of the Maritime States. Shri R. C. Choudhury Secretary, Fisheries, Kerala chaired the session Dr. G. Santhana Krishnan and Dr. Ponnuchamy of MPEDA were the rapporteurs. Status papers in respect of Pondicherry, Orissa, and West Bengal were presented during this session by Shri E Palani, Shri Kindo and Shri A K Barman respectively. During this session, some of the leading farmers shared their experience and problems to be solved in prawn farming. The original texts of these status papers are included in the proceeeings.

Concluding Session

The concluding session which was chaired by Shri V C Pande, Additional Secretary, Ministry of Commerce, Govt. of India was attended by all the Directors of Fisheries of Maritime States their representatives and the Directors of

National Research Organisations. The draft recommendations prepared by the Action plan Committee presented by Dr. Silas were dicussed in detail and the recommendations of the seminar were finalised.

After the concluding session all participants including prawn farmers from various States were taken for a field visit to the Chilka lake area to see the prawn farms developed for ERRP beneficiaries by fue State Govt of Orissa.

RECOMMENDATIONS

Introduction

1. The Seminar on 'Present Status of Prawn Farming in India' was organised on 8-9th May, 1985 at Bhubaneswar by the Marine Products Export Development Authority (MPEDA) in association with the State Bank of India, Orissa Circle. Papers on the present status of prawn culture technology available in the country were presented by the ICAR Research Institute, the Central Marine Fisheries Research Institute, the Central Inland Fisheries Research Institute, the Central Institute of Fisheries Eduction and theCentral Institute of Coastal Engineering for Fisheries. Papers from the State Bank of India and the General Insurance Corporation of India discussed the availability of finance and insurance cover for prawn farming programmes. Status papers presented by the Directors of Fisheries of the Maritime States and the Union Territories analysed the developments in the field of prawn farming and also the proposals for the VIIth Five Year plan.

2. The objective of the Seminar was to focus attention on the urgent necessity to pool all the available resources for the speedy development of prawn farming programmes to augment export production of shrimps. This objective was sought to be achieved by co-ordination and directing the work of different agencies in the field and by properly planning the programmes of the Central and State Governments and their agencies.

3. A Committee with Dr. E.G Silas, Director, CMFRI, Cochin as Chairman drafted the general and specific recommendations of the Seminar on basis of the papers presented and the discussions that took place. At the conculding session chaired by Shri V C Pande, Additional Secretary, Ministry of Commerce and attended by Dr. Kanungo, Adviser, Planning Commission, Chairman, M P E D A, Directors of the Research Institutes, Secretaries / Commissioners / Directors of Fisheries of State Governments and other Officers, the draft of the recommendations was discussed in detail for finalisation.

4. Recommandations

4.1. As Aquaculture of prawns is an important means of animal food production as well as of earning valuable foreign exchange to the country, prawn farming in brackishwaters be assigned priority in the Fisheries Development programmes of the country.

Follow up action :

Ministry of Agriculture
Ministry of Commerce
State Departments of Fisheries

4. 2. The present land and water use policies in the coastal zone vary from State to State and they are not conducive to development of aquaculture. State Governments should therefore modify their policies regarding allotment and use of brackishwater areas in order to

ensure availability of suitable areas for private entrepreneurs and corporate bodies.

Follow up action :

State Departments of Fisheries

4. 3. The papers presented and the subsequent discussions have indicated that additional area of 100 to 500 ha/ year could easily be brought under prawn farming in all the States while it is possible to develop much larger areas in the States of West Bengal, Orissa, Andhra Pradesh, Kerala and Gujarat. The States may develop a comprehensive and integrated action plan including the requirements of different inputs and their utilisation.

Follow up action :

State Departments of Fisheries
Ministry of Agriculture
MPEDA

4. 4 As reliable data on the land and water areas suitable for prawn farming is not available, comprehensive survey be carried out in each State, to prepare area maps locating areas suitable for development of prawn culture.

Follow up action :

State Department of Fisheries
CICEF
MPEDA.

4. 5. To meet the shortage of experienced aquaculture Engineers, the Engineers presently engaged in the development of prawn farms be given intensive training in the aquaculture engineering faculty of the I I T Kharagpur. The I I T Kharagpur may, if necessary, be given financial and other facilities to organise such training.

Follow up action :

MPEDA
I I T Kharagpur

4. 6. Extension is one of the weakest links at present in the aquaculture of prawns. The extension and training base in all States and Union Territories be strengthened with adequate financial supports for building up training facilities.

Follow up action :

Ministry of Agriculture/ICAR
State Departments of Fisheries

4. 7. Appropriate training needs for Extension workers, Farm Managers, Supervisors, skilled operators and hatchery technologists be assessed and arranged in institutions having expertise and facilities for such training.

Follow up action :

Ministry of Agriculture
State Departments of Fisheries

4. 8. The MPEDA is vitally concerned with production of prawns and schemes for augmenting it on account of the foreign exchange that can be earned from the export of prawns. The Ministry of agriculture, its agencies and the State Departments of Fisheries are also concerned with the implimentation of schemes for prawn farming in the context of their general fishery development plans, and their socio-economic impact on large sections of people. However, inspite of the efforts of many agencies and the large potential, as no breakthrough has been achieved in prawn farming, it is necessary to co-ordinate

their activities under dynamic leadership. The role of various agencies of the Central and State Governments may also be demarcated.

Follow up action :

Ministry of Commerce / MPEDA;
Ministory of Agriculture / ICAR;
State Departments of Fisheries

4. 9. Establishing hatcheries, farms and their corollary infra-structure facilities and their operation require large capital investment and adequate managerial capabilities. Therefore, corporate bodies which have the necessary resources should be encouraged to enter this field. The land allotment and utilisation policies of Government should, if necessary, be modified to facilitate this. As such large projects would be export-oriented, the MPEDA may take the initiative in promoting them in consultation with the Central and State Government agencies concerned.

Follow up action :

MPEDA; State Departments of Fisheries

4. 10. Keeping in view the large identified requirments of post larvae in the eastern coast, the initiative taken by the MPEDA in setting up hatchery projects in the States of West Bengal, Orissa, and Andhra Pradesh was timely, and efforts should be made to expedite implementation of these projects with the best available technology in the world.

Follow up action :

MPEDA; State Departments of Fisheries concerned

4. 11. The absence of an agency to do nursery rearing of prawn larvae produced in the existing hatcheries was noted. As it was necessary to rear the hatchery larvae to stockable sizes in the grow out system, appropriate cost effective nursery practices have to be developed. The necessity to set up "Seed Banks" and the scheme of assistance proposed by the MPEDA for setting up seed banks were appreciated in this context.

Follow up action :

Ministry of Agriculture/ICAR
State Department of Fisheries
MPEDA.

4. 12. (a). Taking into account the potential, the present status and the institutional set up, it was felt that intensive and co-ordinated efforts be taken to develop export-oriented brackishwater prawn farming in the States of West Bengal, Orissa and Gujarat in the first phase. (Kerala had already drawn up an integrated project for prawn and fish culture.)

Follow up action:

MPEDA; State Departments of Fisheries concerned

4. 12 (b). Keeping in view the position explained by the representatives of the Governments of West Bengal, Orissa, Andhra Pradesh and Gujarat, the MPEDA should take the initiative for making immediate arrangements for early completion of microlevel surveys and preparation of feasibility studies in these States in consulation with the State Government Departments concerned.

Follow up action :

MPEDA; State Departments of Fisheries concerned

4. 12 (c) The MPEDA may in consulation with the State Government of West Bengal, Orissa, Andhra Pradesh and Gujarat, consider the institutional frame work necessary for organising integrated brackishwater prawn farming schemes in these States.

Follow up action:

MPEDA, State Departments of Fisheries concerned.

4. 13. The aqua-climatic features of the coastal zone differ greatly from region to region. An "ecological aquaculture" with optimum utilisation of the prevailing ecological factors be developed for each area and the package of practices evoled for the management of prawn farms be made available to the implementing agencies/ farmers/entrepreneurs.

Follow up action:

Ministry of Agriculture/ICAR, State Finisheries Departments; MPEDA.

4.14. Use of saline ground / sub-soil water is utilised successfully for prawn cuiture in closed ponds in certain areas of Andhra Pradesh and Orissa. Dedicated research be undertaken on all aspects of this practice, so that adequate scientific back-up is provided to the implementing agencies and the farmers.

4.15. Though feed is one of the essential inputs to enhance production in the grow-out pond system, no such feed is available readily in the market. Necessary research efforts to develop cost effective feeds utilising the locally available raw materials be immediately stepped up by research organisations.

Follow up action is also required on the one hand, to organise commercial manufacture, and on the other hand, to popularise use by the farmers.

Follow up action :

ICAR/MPEDA.

4.16. The development of prawn farming in the manner envisaged in the Seminar needs finance to establish hatcheries, farms and corallary infrastructural facilities. Finance is also required to meet the operational costs. Although, there is considerable awareness about the potential, financial agencies are often hesistant to enter the field on account of lack of adequate information and proven economics of culture. Several instances are now available to show the techno - economic feasibility and profitability of prawn farming. Hence, banks and institutions like NABARD should extend their whole hearted support to prawn farming projects, particularly as the General Insurance Corporation has now agreed, in principal, to provide insurance cover for such schemes.

Follow up action:

Development & Commercial Banks, NABARD

4.17. Financial and technical assistance may be provided by the Central and State level promotional agencies to improve the techno-economic viability of the projects, particularly in the initial years.

Follow up action :

State Departments of Fisheries MPEDA.

PRESENT STATUS OF MARINE PRAWN HATCHERY TECHNOLOGY IN INDIA

E. G. SILAS and M. S. MUTHU

Central Marine Fisheries Research Institute, Cochin - 18

Introduction

One of the reasons for the rather slow growth of the prawn culture industry in India is the non-availablity of the seed of desirable species of prawns at the proper time in adequate quantities to stock the grow-out ponds. At present, there are approximately 30,000 ha of traditional prawn culture fields existing in the country mainly in West Bengal, Kerala and Karnataka. If 2-3 crops of prawns per year are to be cultivated in these fields on scientific lines at a stocking density of 40,000 *P. Indicus* seed/ha/crop or 15,000 *P. monodon* seed/ha/crop, we need 2400-3600 million seed of *P. Indicus* or 900-1350 millian seed of *P. monodon* per year. The natural prawn seed resources available in the surf and estuarine regions are totally inadequate to meet these requirements. Their occurrence in nature is also seasonal and sporadic and does not necessarily synchronize with the good growing seasons. Therefore, for ensuring a steady supply of quality prawn seed to the prawn culturists at appropriate times we should establish more prawn hatcheries all along our east and west coasts. To supply prawn seed for growing at least 2 crops in the existing 30,000 ha, we need 48 hatcheries of *P. Indicus* or 18 hatcheries of P. *monodon*, each hatchery capable of producing 50 million prawn seed per year. It is evident that there is an urgent need to estabtish large scale hatcheries in the maritime states to cater to this colossal demand for prawn seed.

Prawn hatchery work at the Central Institutes

The Central Marine Fisheries Research Institute (CMFRI), Cochin realising the importance of developing indigenous technology for hatchery production of prawn seed, initiated work in late 1975 at its Narakkal Prawn Hatchery Laboratory (NPHL) on breeding of penaeid prawns in captivity and rearing the spawned eggs through the various larval stages to the postlarval stage on a large scale. Intensive and directed research on factors that affect maturation and spawning of marine prawns in captivity and on the morphology, behaviour, feeding habits and nutrition of the larvae of commercially important penaeid prawns was undertaken. The accent was on developing a low-cost technology utilizing locally available raw materials for hatchery production of prawn seed. The capital intensive Japanese, American and French systems of larval rearing involving the

use of pure cultures of phytoplankton and freshly hatched naupli of brine shrimp for feeding the various stages of larvae were discarded and totally indigenous systems of rearing were developed. The techniques were refined and modified over the past 10 years to increase the survival rates and to simplify the procedures to make the technology economically viable under Indian conditions. The hatchery technology evolved is in fact a package of practices involving the following components. (1) Inducing farm-grown broodstock prawns to mature and spawn in land-based maturation facility through unilateral eyestalk ablation and control of environmental factors. (2) Production of mixed cultures of diatoms in 1 tonne capacity fibreglass tanks by fertilizing raw seawater with inorganic nutrients and exposing it to sunlight. The diatom bloom develops within 15-20 hrs and is used for feeding the protozoea and mysis stages. The larvae are raised on an exclusive diet of phytoplankton upto the last mysis stage. (3) Development of a dry particulate diet based on readily available inexpensive raw materials such as prawn waste, mantis shrimp, fish meal, groundnut oil cake and tapioca powder for feeding the postlarval stages.

Using these techniques over 500 females of *Penaeus indicus* have been made to mature and spawn at the Narakkal Prawn Hatchery Laboratory during the past two years. About 70% of the eye ablated females (145-155 mm in total length) kept in the maturation pools mature and spawn predictably, 4-5 days after unilateral eye stalk removal. The average number of eggs produced is 80,000 per female and the average hatching rate is 87.5%. The larval rearing system in which 75,000 nauplii are stocked in one m^3 of sea water results in an average survival rate of 50% from the nauplius (N 1) to the 5th postlarval (PL 5) stage. Over 5 million PL 5 per season (5 months) have been produced at the Narakkal Prawn Hatchery Laboratory during the last two years. The NPHL has the distinction of being the only hatchery in India were *P. indicus* has been practicaliy "domesticated", The entire life cycle of the prawn is completed in the farm itself without the prawn going back to the sea for maturation and spawning. *P. indicus* has been maintained for five continuous generations at the NPHL.

On the basis of the results obtained at the NPHL, the capital investment for starting a commercial hatchery that can produce 35 million PL 5 of *P. Indicus* per year is estimated to be around Rs. 11 lakhs. The recurring expenditure (including interest on loan, depreciation, salaries, contingencies etc.) will be about 3.8 lakhs. The cost of production of 1000 PL 5 is estimated as Rs 10.9 if interest on loan and depreciation are included in the recurring expenditure. The production cost is just Rs 4.18 per 1000 PL 5 if only the salaries, operating costs, contingencies and maintenance costs are included in the recurring expenditure. If the PL 5s are sold @ Rs 16 per 1000 the net profit after repayment of loan instalments, works out to be 9.55%, 13.55% and 19.1% (of the capital investment) at the end of the 1st, 2nd and 3rd year of hatchery operations.

Using the techniques developed at the NPHL the CMFRI has successfully produced over 10 lakh postlarvae of the tiger prawn *P. monodon* about 1 lakh postlarvae of the Japanese Kuruma prawn *P. japonicus* at their field station in Kovalam near Madras and about 5 lakh postlarvae of *P. semisulcatus* at their field station in Tuticorin. The eyestalk ablation technique induced maturation has been successful with all these 3 species of prawns as well.

The CMFRI has also been conducting 3-4 week training courses and Summer Institutes to transfer the prawn hatchery techniques, as and when they were developed, to the State Government officials and the teaching and research staff of Universities and Agriculture Universities. Under this transfer of technology programme the CMFRI has conducted 2 Summer Institutes and 4 training courses on prawn breeding and rearing at the Narakkal prawn Hatchery Laboratory between 1977 and 1985.

The technology package developed by the CMFRI for hatchery production of penaeid prawn seed has been published in the form of a manual giving complete details about the technique of induced maturation and spawning by eyestalk ablation, larval rearing procedures, culture of phytoplankton to feed the larvae and preparation of particulate feed for the postlarvae. Criteria for selecting a site for the hatchery, infrastructure facilities (including buildings and equipment) needed for a hatchery and the economics of production of prawn seed are also discussed in the manual.

The Central Inland Fisheries Research Institute (CIFRI) has been trying to rear *P. monodon* at Puri without much success. Recently the CIFRI has been able to rear one brood of *P. monodon* larvae to the postlarval stage at its newly set up facility at Ennore near Madras. However, the details of the experiments are not yet available.

The Central Institute of Fisheries Education (CIFE) is said to have developed a larval rearing method using yeast, egg-custard, *Acetes* and zooplankton to feed the larvae. A demonstration unit is situated at its farm in Kakinada. However no details are available about the procedures followed and the survival rates obtained.

The Marine Products Export Development Authority (MPEDA) is setting up a prawn hatchery with foreign collaboration at Vallarpadam near Cochin. It has not yet been commissioned.

Commercial Prawn Hatcharies

The Regional Shrimp Hatchery of the Kerala State Fisheries Department at Azhikode and the private Crecent Hatchery at Eriad are producing prawn seed on a commercial basis. The Regional Shrimp Hatchery produces about 4-5 million seed of *P. indicus* and *P. monodon* every year. *P. indicus* postlarvae (PL 8 - PL 10) are soid @ Rs 25/- per thousand and those of *P. monodon* are sold @ Rs 35-50 per thousand. These two hatcheries use crustacean tissue suspension to rear the larvae in 2 to 15 ton capacity outdoor tanks and depend on wild spawners collected from the sea to obtain the eggs for

rearing. We have no information about the economics of these hatchery operations.

Other efforts at the State Level

The State Fisheries Departments of Gujarat and Orissa have started small experimental prawn hatcheries at Okha and Paradeep respectively. These hatcheries are manned by staff who have been trained at the Narakkal Prawn Hatchery Laboratory of the CMFRI. At Okha some success has been achieved in rearing *P. merguiensis* to postlarval size while the emphasis at Paradeed is on *P. monodon*. The infrastructure facilifies of these two centres should be improved to achieve better results.

Remarks

It is clear that indigenous technology is available in India for hatchery production of penaeid prawn seed. In the face of these recent developments outlined above the search for foregin technology in certain quarters for establishing prawn hatcheries is unwarranted. Foreign technology is capital intensive and requires sophisticated equipment and highly skilled technicians to operate the hatchery. It should also be remembered that technology developed in other countries may not work under Indian conditions unless they are suitably modified. What we need is a simple, low-cost technology suited to Indian conditions and one which can be adopted even by small entrepreneurs. We should be happy that Indian scientists have developed just such a technology.

PRESENT STATUS OF BACKISHWATER SHRIMP FARM MANAGEMENT TECHNOLOGY IN INDIA

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Introduction

There has been a new-found global interest in brackishwater aquaculture for well over two decades. This mood was reflected in a way by the symposium on coastal aquaculture organised by IPFC in the year 1970 in conjunction with its fourteenth session in Bangkok, Thailand. Many countries in south and south-east Asia have traditional systems of brackishwater aquaculture region but show visible signs to adapt to new set of practices that modern farming technology offers in this area of activity.

India, too has a traditional system of culture of brackishwater finfish and shell fish, which was practised largely in the States of Kerala and West Bengal in low lying paddy fields adjoining backwaters and estuaries. The brackishwater aquaculture has gathered further momentum in this country in recent years for reasons that marine shrimp production has reached a plateau and that brackishwater shrimp culture has potential -

1. To augment shrimp production and enhance our foreign exchange earnings through export.

2. To put to optimum use of saline, agriculturally low productive, swampy land for brackishwater aquaculture either alone or in conjunction with paddy plots depending on elevation of land *vis a vis* mean sea level, salinity features, tidal amplitude etc.

3. To improve socio-economic condition of coastal dwellers

Our approach to brackishwater aquaculture will have to be in line with Government policy and philosophy which, *inter alia,* lay stress on area development and improving the lot of coastal poor. The current culture technology and farm management technology in a way reflect this approach and is oriented towards low-cost production technologies. Many of the affluent countries have opted for high cost and high production technologies for shrimps where the production cost of shrimp exceeds $ 6 per unit weight of 1 kg where the production system is based on high stocking rate, total formulated feed and water management. The cost of production diminishes to a third if technology is based on augmented natural food through fertilisation, supplementary feed and relatively low stocking density. The latter aspect took a major share of research efforts of Central Inland

Fisheries Research Institute on Penaeid shrimp culture during last 17 years relevant to pond-oriented production system.

Various estimates are available on brackishwater culture area in this country but none of them is based on actual physical survey. The latest to emerge puts the estimate at 9 lakh ha, the east and west coast sharing this area nearly equally. This figure would diminish further if the area is subject to micro-level survey, ecological screening to exclude potential natural nursery areas, unfavourable soil quality and tidal amplitude, unfavourable climate, pollution natural hazards including cyclones and floods etc.

Brackishwater culture is at Present practised in the country in an estimated area of 45,000 ha of which 75% is located in West Bengal in deltaic Sunderbans while Kerala accounts for 7,000 ha, Karnataka 2,500 ha, Andhra 4,000 ha and Goa 500 ha. The brackishwater culture system in the country belongs to the following categories:

1 Brackishwater culture in low lying paddy fields adjoining backwaters and estuaries sequentially (Kerala model)

2 Brackishwater culture in low lying paddy fields simultaneously and sequentially (West Bengal model)

3 Brackishwater culture in perennial impounded estuarine swamps (West Bengal model)

4 Brackishwater shrimp farms: pond-based production system. Pond (term used interchangably to include paddy fields and brackishwater impoundments) management practices followed in these systems are examined in this communication in the context of culture practices followed under different production systems. The paper gives baseline information on location (site selection) tidal amplitude, layout, design, feeder canal, dykes, sluices, silt trap considered necessary for discussion on pond management relating to augmenting natural food and higher survival of shrimp etc. and production and economics. The culture systems include both finfish and shrimp and as such farm management practices described here in a way are not restricted to shrimp pond management only though focus is mainly on this aspect.

The penaeid shrimp cultivation in this country presently depends largely on wild seed either taken in with the tide in the production units or stocked with seed collected from the wild. While wild seed shrimp culture is made of number of species belonging to *Penaeus* and *Metapenaeus* genera, stocking is largely made of P. *monodon* and *P. indicus*. The CIFRI has mapped out the occurrence of shrimp seed in the wild in time and space for Hooghly-Matlah estuarine system, Chilka lake, Pulicat Lake, Kalinga coast, Northern circars and coromondal coast on the east and Malabar and Konkan coasts on the west India. A *monodon* seed trade has developed in West Bengal based largely on Institute's research and extension effort on seed collection techniques,

storage and transport. Recently CIFRI has achieved a breakthrough in production of seed of *P. monodon* and *P. indicus* at its Ennore shrimp hatchery. Other Institutions and private sector enterprises in the country have also reported success in shrimp seed production in hatcheries. A commercial hatchery from shrimp seed is nearing completion in Maharashtra. The studies carried out by CIFRI reveal that it is possible to raise 2 to 3 crops of *P. monodon* in Sunderbans, 2 crops of *P. monodon* and one crop of *P. indicus* in coromondal coast and 2 crops of *P. indicus* in Malabar and Konkan coast. Short term crops (85 days) appear to give better yield (av. 350 kg ha) than long term crops (400 kg / ha 125 days), reaching a size of 50 to 60 gm in long term culture in comparison to 35 gm in short term culture in respect of *P. monodon*. CIFRI studies have shown that it is possible to achieve 1,185 kg / ha in three crops in *P. monodon* in West Bengal. A long term culture (4 months) gave a good yield of 670 kg / ha in *P. indicus* at Madras. The present seminar on the status of shrimp management technology takes place at appropriate time in the context of emerging scenario on shrimp culture front in this country and in the context of formulating suitable production strategies for 7th Five Year Plan.

1 BRACKISHWATER SHRIMP FARM MANAGEMENT (POND SYSTEM)

1.1 Design and lay-out of brackishwater shrimp farm in relation to management

The shrimp farms in West Bengal are located in the lowlying tidal mud flats in the estuaries which are normally inundated to a depth of 1 m or more during spring tides but are fully exposed at low tides. Construction of shrimp farms followed detailed engineering survey to know the shape and size of the land, its topographical features and tidal dynamics. The soil in the deltaic region of West Bengal is mostly silty or siltyclay with some percentage of sand. The soil is generally water retentative. The ground elevation of most of the shrimp farms varies from 0.80 m to 1.50 m (m.s.l.) The tidal amplitude helps in efficient water management in shrimp ponds.

The farm layout is decided according to the topography of the site. A well designed shrimp farm complex has an inlet (feeder) channel with a manually operated head sluice, nursery ponds, stocking ponds, perimeter dyke, partition dyke and secondary sluices for the ponds. A clear margin of 50 m of mangrove forest belt is left between the farm and the adjoining estuary for safety of the farm against tidal thrusts and soil erosion.

Siltation is a major problem in tidal estuaries which often make the farm management difficult and interferes in production processess. Silt trap is provided in the farm at the end of the main sluice where the silt carried by the ingressing tide water is allowed to settle down before entering the farm ponds.

The bed of feeder channel and farm ponds is normally maintained above the average low water level during neap tides to facilitate quicker filling and emptying the ponds as and when required.

The entire land is protected by stable earthen dyke on all sides. The dyke is built sufficiently strong to withstand tidal impacts, erosive forces from rains and wind and against over-topping. The river side face of the perimeter dyke is given flatter slope, sometimes covered with brick lining to prevent slipping of the dyke. Puddle core with clay soil is provided in the centre of the dyke to make it perfecfly leakproof.

1.2 Pond preparation and management: Exposure of pond bottom

Saline soils tend to be low in productivity. High saline soil is not conducive to the release of nutrients for organic growth. After harvesting the standing crop from the pond, the entire saline water loaded with metabolic wastes is drained out and the pond bed is exposed to sun for drying This practice is followed in brackish-water impoundments. This is done in the dry season. Silt deposits are also flushed out during this operation. Exposure of the bottom soil facilitates removal of all harmful gases, such as hydrogen sulphide, from the mud, and helps kill many pests and predators. Raking and tilling of the exposure of pond bottom to sun help increase mineralisation and the soil fertility. Where draining is not practical in large ponds, raking the slushy bottom and addition of lime are practised to remove the obnoxious gases.

Pond management for improved fertility and good survival of shrimp

The primary objective of fertilisation in brackishwater prawn farms is to encourage the growth of benthic algae which form the major food for penaeid shrimps. These algae normally derive their nutrients either directly from the soil or from the soil-water interphase. As such fertilizers are better applied at the pond bottom, rather than at the water phase in shrimp ponds.

The types and levels of application of fertilisers and manures in shrimp ponds, depend largely on the nature and properties of the shrimp pond soil. The pond soils in low lying coastal areas, fed by saline tidal water, vary in PH and nutrient status. These aspects are given consideration normally in the selection of fertilisers and manures.

In addition to organic manuring, nitrogen and phosphorus are the two major nutrient elements which are applied in brackishwater ponds in the form of inorganic fertilisers. The ammonium career fertilisers are generally considered better nitrogenous fertiliser than nitrate-careers for use in brackishwater ponds as a large amount of the ammonium ions are absorbed in the exchange complex of bottom soil and benefit the benthic algae which derive their nutrient either directly from the soil-water interphase.

Phosphatic fertilisers used in aquaculture are mostly soluble in the water under optimum PH range. Under brackish-water environment a large portion of applied water soluble phosphorus is precipitated as insoluble calcium phosphate, rendering it unavailable at the soil phase. To avoid such a loss, these fertilisers should be applied in spilt doses in combination with organic manures. Use of rock phosphate in brackishwater

fish ponds is considered appropriate for acid soils encountered on the west coast. Under such conditions not only does the fertiliser release larger amount of phosphorus in available form but also the high calcium content in rock phosphate helps to reduce the soil acidity to a considerable extent.

Organic manures are by far more commonly used than inorganic fertilisers for augmenting productivity of shrimp ponds. Nature of transformation of organic matter in fish ponds is, however, different from that on land. Decomposition of organic matter in submerged environment results in production of CO_2' methane, different organic acids, alcohol etc. depending on the extent of reduction reactions in the soil. High concentrations of these are not only not conducive to the environment hygiene for bottom dwelling prawns but also impede the productivity of shrimp food organisms at pond bottom. But organic manures, like rice bran and oil cake at optimum doses facilitate growth of benthic algae. The use of compost is also considered desirable but needs further evaluation.

The results obtained so far from different fertiliser trials in brackishwater ponds by CIFRI indicate that adoption of following methods for fertilisation for nursery and culture ponds yields better results in brackishwater prawn farming.

Nursery pond management includes application of mahua oil cake, followed by treatment with lime @ 200 kg ha. Application of lime prevents, not only development of unhygienic condition in the pond, but also provides sufficient amount of calcium, which is highly essential for shell formation of prawns This is especially required in low saline brackishwater ponds, as encountered on western bank of Chilka in Orissa and ponds located on acid soils in southern States. Addition of lime during nursery pond preparation has been found to increase the survival of *P, monodon* from 30% to 50-72%.

The doses of manure and fertilisers recommended for nursery ponds are poultry dropping @ 1,000 kg/ha/yr and urea and super phosphate @ 250 kg ha yr each for ponds showing optimum pH.

Culture pond management includes application of a basal dose of organic manure like poultry droppings, rice bran or oil cakes to the soil @ 50-100 kg/ha along with inorganic fertilisers such as urea and superphosphate @ 50 kg each. This dosage is found effective at salinity regime of 5-10 ppt. The rates are increased gradually as the salinity increases. After application of this basal dose, water is drawn to a depth of 10-20 cm and allowed to stand for 5-6 days to facilitate a thick growth of lab lab. The water depth subsequently is raised to and maintained at 80-100 cm. Fertilisation is repeated at monthly intervals in between water exchange period to avoid nutrients drawing out of the ponds with outflowing water.

Water quality managemet in post-larval acclimatisation

Hatchery-produced and wild stock of post-larvae are delicate to handle and sensitive to sudden changes in ambient water resulting in heavy mortality. Post-larvae, from wild collection are pre-conditioned before release in stock ponds.

The time required for conditioning may vary from 3 to 48 hours, depending on differences in salinity and temperature between estuarine and pond waters. Conditioning is done by gradual mixing of pond water with estuarine water in which the prawns are held. Stocking is done during late evening when dissolved oxygen content in water is optimum.

An interface of nursery rearing ensures a better survival of shrimp juveniles in stock ponds.

Water quality control in stock pond management

The quality of pond water determines growth rate, stock size and health of shrimp under cultivation. Dynamic changes take place in the environment of brackishwater ponds receiving tidal water, especially in respect of temperature, salinity, pH, D.O. besides nutrients. There are a number of ways to improve the quality of pond water for optimum metabolic processes in shrimps. Water circulation and renewal are good management tools in shrimp culture. The use of raceways, running water or water recirculation system is increasingly resorted to, to support greater concentration of the cultivated species in other countries though not practised yet in this country.

Adequate aeration is achieved by renewal of the pond water by tidal ingress or by using pumps.

Algal bloom may deplete DO in pond water during night and supersaturation during day time causing at times mass mortality of stocked species. Proper preparation of the pond bottom, regulation of water level in the pond and regulated use of inorganic fertilisers are needed in controlling algal bloom. In extreme cases some non-toxic chemicals are used for algal control besides use of biological agents.

Metabolites are the wastes occuring in the pond system from the high density standing crop of shrimps and fish in the water. The metabolites settle down and decompose. Accumulation beyond a certain level results in anaerobic condition. Flushing with strong tidal current keeps the bottom almost free from metabolites. This practice is variously followed in this country, while aeration other than tidal exchange for increased oxidation is not common.

Pond management for predator and pest control

In shrimp ponds, growth rate of stocked species declines if other food competitors are present. Small fishes, snakes, eels and crabs all act as competitors. Intermittent netting is found to help in eliminating these undesirable species. The presence of crabs and eels are otherwise also harmful as they create tunnels in the pond through which stocked species escape while facilitating entry of predatory species into ponds. These tunnels and holes cause leakage and render maintenance of water level difficult These tunnelling species can be checked by applying calcium carbide or quick lime in the burrows. Various types of snails consume large amount of benthic algae and are found to compete for food with the stocked prawns. Entry of

predatory fish like *Lates calcarifer* and *Eleutheronema tetradactylum* and Eels reduce yield in shrimp ponds. Incorporation of effective wire mesh screens or velon net screens in sluice structures is done, but this does not ensure against entry of eggs and larvae of undesirable species.

Disease

Parasites are harmful as they affect the growth of shrimps. Disease causing parasites are known to cause heavy mortality. In cultivated prawns in general and more particularly in *P. monodon*, few cases of Bopyrid infection was reported' Unhygienic pond bottom with excessive deposition of organic matter accompanied by high density of stock form the favourable environment for the parasites. Flushing the pond with fresh tidal water and dip of affected species in 5 ppm potassium permanganate solution is recommended.

Cannibalism

Cannibalism is characteristic of prawns. Bigger prawns generally predate upon other living prawns during ecdysis. The loss due to cannibalistic habit in prawn can be minimised by taking care to provide adequte feed, shelter etc. Shelter In the form of palm leaves is provided in various locations of the pond. This acts, in addition as substrate for periphyton growth which forms a good food tor prawns.

Water level regulation for harvesting

One of the principal problems faced by shrimp culturist is harvestig. Netting and trapping are only partially effective. Partial draining is done before first netting. After the entire pond is drained out, hand picking is done to search for the buried prawns. Lowering of level and maintaining at low level for some days render the water to hot up. This makes the prawn to come out of shelter and render them easy for hand picking.

Pond management for habitat improvement.

Salinity

Salinity as a single factor often limits the production in the brackishwater pond by inhibiting the release of certain nutrients or by making the environment uncongenial for the growth and survival of certain organisms which may have limited tolerence limit They also inhibit growth and even mortality in shrimps if pond water is subject to sudden and sharp changes in salinity. Proper care must be taken to prevent entry of flood water into shrimp pond especially those holding *P. indicus*

pH

pH less than 6 is often found harmful to penaeids. Pond bottom sloping towards drain helps flush out low pH water out of production unit.

Dyke management

Saline soils are generally of low consistency and when dry the contract and on being wet they change into a quagmire. Since it is difficult to grow vegetation on saline soil, cracks very often develop in the dykes. With the break of monsoon, rain water passes through these cracks, develop internal tunnel and result in large scale land sliding of the earth from the dyke.

Periodical maintenance works done to keep the farm ponds and dykes in

perfectly working condition. Desiltation of the ponds is done normally during winter months when the tidal amplitude is less. Silt removed from the pond is effectively utilised in repairing the damaged pond dykes.

Balanus colonies which adhere to the wooden sluice gate are removed by regular scrapping the wooden surface. Antifouling paints or coal tar are applied on the surface to check the growth of fouling organisms.

2. RICE-CUM-SHRIMP CULTIVATION IN INDIA

Saline soils of various levels of salinity are encountered as far hinterland as 200 km depending upon river system, latitude, tidal amplitude and range, and according to some estimate it covers an estimated area of 3 million ha. Almost the entire area of the rainfed coastal saline soils has a single crop of kharif rice grown during monsoon period when salinity is low. During rest of the year, the fields usually remain fallow due to high salt content of the soils, compounded further by the problem of want of good quality irrigation water.

The kharif paddy varieties widely used in such areas are SR-26-B, CSRI, CSR-2, CSR-3, Pankaj, Pokkali, Kalomota, Masuri and other local salt tolerent varieties. Paddy cultivation in these areas, being almost entirely dependant on monsoon precipitation and accentuated further by low productive saline soils, the yield is far from satisfactory.

Paddy-cum brackishwater fish and shrimp cultute system evolved over the years in the country, aims at utilising the fallow period of the coastal paddy fields for a short term brackishwater aquaculture, without interfering with the subsequent kharif paddy crop. The system provides the farmers of such mono-cropped areas with a substantial Subsidiary income. The sequential system, largely practised in Kerala, is now increasingly adopted in West Bengal, where earlier a simultaneous system of culture of fish and shrimp with paddy was a traditional practice.

2. 1 Sequential cultivation of rice-cum-shrimp (Kerala model)

The Kerala has a long tradition of shrimp and fish farming in the low lying areas along the coast, and is largely practised along the banks of Vembanad lake and estuaries of Periyar and Pamba rivers. Penaeid shrimp (and fish) cultivation is practised during the agriculture off-season in October-Aprii period in the fallow paddy plots along backwaters and estuaries that abound in natural shrimp ann fish seed and transported alongwith tide. Nearly 5000 ha of such paddy field are so utilised sequentially for paddy brackishwater shrimp (and fish) cultivation. During south-west monsoon a saline resistant local variety of paddy known as 'Pokkali' is generally cultivated. The paddy is harvested sometime in Septmber with an yield in the range 1500-2500 kg per hectare.

Shrimp farming follows paddy harvesting in Septmber. The dykes of paddy fields are strengthened by borrowing earth along the inner periphery after leaving a margin of land. The 'borrow' pits serve as channels or trenches. The dyke strengthening process also ensures plugging of holes made by crabs. A semicircular depression is made inside

opposite the sluice. This is connected to channels, cut into the field that has a slope towards sluice. These structural changes in the field facilitateintake of tidal water across through the entire field and in drainage. The shrimp farming is done in units varying in size from 1 to 30 ha by a lessee but holdings belong to a number of owners.

The sluice gate is a rectangular wooden structure and is made of local timber. It is located on the outer dyke at a place that ensures maximum water flow and drainage. The sluice gate, generally a meter wide, is made of a bottom platform, side frames with grooves for sliding the shutter planks and a top frame, all assembled into a single unit. The shutter is operated by rope.

During high tide the tidal water is let into the field through the sluice. A hurricane lamp is hung on the sides of sluice mouth during night to attract prawn juveniles. A bamboo/arecanut screen is fixed on the inside mouth of sluice to prevent escape of prawn juveniles when water is let out during low tide. These operations are continued over the whole lease period.

Harvesting is done three to four days around full moon and new moon. A cotton conical bag net with close-meshed cod end is fixed on the outside sluice mouth to collect the shrimps as shutter planks are removed. The cod end is attached to floats to monitor level of catch inside the bag going by level of submergence. A conical net is also fixed on the inside infront of sluice gate with open cod and pointing away from sluice to prevent impounded prawns escaping out when tidal water is drawn in. Towards the end of shrimp culture operation, total harvesting is done by keeping water level low and resorting to cast netting, drag netting and hand picking.

In the shrimp filtration system yield is in the range 500-650 kg/ha and the catch upto 70% is made of *M. dobsoni* and upto 20% of *P. indicus*. This is in addition to an yield of 2000 kg/ha from paddy cultivation.

It is reported that in sequential paddy and shrimp cultivation the farmer has a gross receipt of Rs. 10,000/- and a net profit of Rs. 2500/- per hectare.

Shrimp filtration system is also practised in perennial fields in some selected area in Vypeen island where agriculture is not possible. These fields. range in size from 2 to 70 hectare and from only 10% of area in the shrimp filtration system,

2.2 Simultaneous and sequential cultivation of shrimp with rice in low and medium saline areas (West Bengal model)

In the State of West Bengal, brackish-water fishes and shrimps are cultivated alongwith paddy largely in subdivision of Basirhat and Barasat. These paddy fields have strong embankments all around and linked to canal network of varying size and design within the field. On an average about 8% of the area of such fields is occupied by canals varying from 0. 6 to 1. 5 m in depth. Harvesting operation of 'Kharif' paddy generally commences in these fields in the month of November and is over by about

January, when the field as well as the canals are completely dry. From February or March onward, tidal water with shrimp and fish seed is taken into the dyked field canals at high tide. Till the onset of the monsoon the water level in the canals is maintained much below the level of the paddy field by regulation of operation of sluice gate. The intake of brackishwater into the canals is stopped by about June when the South-West monsoon sets in and the paddy seedlings are transplanted. By August, water level in the canal increases due to accumulation of rain water when the paddy plots also get inundated. Salinity of canal water reduces appreciably, and bunds along the canals are then breached so as to merge the water in the canals are with the paddy plots. This enables shrimps and fishes to gain wider access to paddy plot proper for further growth. The major species of fish and prawns cultivated in the paddy field for 4 months are mullets and *Penaeus monodon, Macrobrachium rosenbergii, Metapenaeus brevicornis, Metapenaeus monoceros* and *Macrobrachium rude*. Production of fish and prawns in these paddy fields ranges between 200 and 400 kg/ha/4 months. These fields. in general vary in size from 2 to 40 ha. In this system, the farmers maintain dyke height at 0.5 - 1.0 m which is strengthened periodically with earth borrowed from the trenches dug along the dyke inside the field. The sluice is located at a place that ensures maximum intake of water as well as drainage. In addition to the perimeter field channel, there exists a main field canal commencing from the inside mouth of the sluice. This main field canal has various bends in its course, and is designed to act as silt traps. The field canal is largely used as a holding chamber for the fry and juveniles of the fish and shrimps taken along with tidal water in spring and summer. These canals are trapezoidal having generally a top width of 2 m and depth of 1 m and of bottom width of 0.5 to 0.75 m. The provision of the dyke is to ensure that the saline water taken into the canal in summer has no access to the main field there-by ensuring the soil quality of the paddy plot. Two types of sluice systems are used in traditional rice-cum-prawn culture plots; in one type there is provision of only single sluice with plank-built drop shutter, and acts as a conduit both for ingress and egress of water. In the second system there are two sluices placed at different levels with top sluice functioning as conduit for intake of water, while the one at the bottom level servihg as an outlet to drain out water. The latter is made of hollow palm trees traditionally but is getting replaced by hume pipes. The traditional sluice gate is largely made of sal wood.

The farmers use bamboo screen traditionally in front of the sluice mouth to prevent the entry of undesirable species while drawing in water during high tide. They also use 'V' shaped (with single opening) or 'W' shaped (with two openings) bamboo 'patas in front of the main field canal with provision of single or two traps at the opening of the 'patas' with a view to capturing outgoing shrimps and fishes during high tide intake of water. In addition to these harvesting devices, farmers also lower the water at the neap tide during harvesting period to capture shrimps

through drag netting, cast netting. etc.

In the traditional system of rice-cum-fish culture farmers do not give supplymentary feed. In recent years, however, the farmers are resorting to fertilisation @ 30-40 kg/N/ha. Supplementary feed are also given by some affluent farmers.

During November-December the farmers utilize the off-months to desilt the canals, strengthen the dykes and attend to other minor repair of sluice gate etc.

Since seventies, a new system of brackishwater paddy-cum-shrimp culture is developing in West Bengal akin to Kerala system with shrimp culture in paddy fields commencing in June. The important shrimps and fishes cultured in this system in West Bengal are *P. monodon, M. monoceros, M. brevicornis, Macrobrachium rosenbergii* and mullets. The current practice is largely based on selective stocking. Many fields in Hasnabad, Basirhat, Malancha, Gopalpur, Haroa, Sandeshkhali, Nazat, Basanti, etc. of North and South 24-Parganas district are adopting the new sequential system, This has not only paved the way for establishing an effective brackishwater shrimp and fish seed trade, but also improved the rural economy of area by increasing the income of small agricultural farmers and small entrepreneurs, who operate the fishery on lease, besides generating employment potential of landless labourers. It was observed that in rotational shrimp culture in rice fields the average expenditure of the lessee of paddy plots for shrimp culture operation is Rs. 30,000/-with a net profit of Rs. 16,000/-on a unit of 1 ha.

2.3 Rice-cum-shrimp culture in high saline area of West Bengal (CIFRI / CSSRI experiments)

Plot selection and design

Most of the coastal area is low lying, the elevation varying usually from sea level to 8m. above MSL. Such low lying high saline area on estuaries, tidal streams, creeks, in belts under a monsoon precipiation exceeding 1500 mm per annum are suitable basically for paddy-cum-shrimp culture, provided they are free from natural hazards, pollution, etc.

For the purpose of paddy-cum-penaeid shrimp culture, paddy plots should be renovated suitably. The height of the dyke is maintained between 50 and 100 cm depending upon the topography. of the plot and tidal amplitude at the site. Perimeter canal is provided on the inner periphery of the plot. For a one ha paddy plot, the width and depth of the canal may be about 2 m and 1 m respectively. Two cross trenches of about 1 m width should also be constructed which join the perimeter canal. The bottom of the trenches is kept above the perimeter canal bed to facilitate drawing of water into the canal through gravity flow. This is designed to drain out saline water completely and render the paddy plot fit for cultivation. Ingress and egress of water into the paddy plot is regulated by wooden box type sluice already described.

Management mix for shrimp culture and paddy cultivation

Judicious field management is essential for the conversion of monocropped coastal saline areas into sequential and simultaneous rice-cum-shrimp cultivation system. During, summer months, with water salinity at 10-40 m mho/cm short term penaeid shrimp culture may be undertaken as a rotational crop. Experiments carried out by CIFRI in West Bengal reveal that, through proper management mix. the ecological condition of the field remains generally favourable for brackishwater shrimp culture during summer. Intake of brackishwater, however must be suspended before the onset of monsoon and the species cultured harvested. The field is then exposed to monsoon precipitation for the purpose of desalination, Duriug rainy season the soil salnity decreases repidly depending upon the extent of monsoon precipitation and E. C. values go down to nearly 4 m mhos/cm. After restoration of congenial ecological condition, the transplantation of kharif paddy seedlings is done Following this operation, juveniles and fingerlings of freshwater prawns and fishes are released into the plot, to obtain the second crop of fish and shrimp alongwith paddy.

Generally, paddy is harvested by the end of November. Freshwater shrimp culture may be extended further upto December, depending upon availability of water. After this, the plot is dried completely and prepared for next crop of brackishwater shrimp culture.

Plot preparation

Plots are prepared in two phases, once for brackishwater shrlmp crop and again for kharif paddy cultivation alongwith frehwater fish. For summer aquaculture crop, the plot is sundried after the kharif harvest. Depending on soil pH (4.0-7.5) lime is applied @ 200-1000 kg/ha to rectify the acid soil and also to minaralise the organic matter.

Usually phosphatic fertiliser application is not necessary as coastal soil is rich in phosphate in West Bengal. However, urea may be used to compensate for nitrogen deficiency in saline soils. Broadcasting of rice-bran @ 1000 kg/ha over the soils has been observed to encourage the growth of lab-lab. At this stage the perimeter canal and the trenches are filled up with the tidal. water and 15-25 cm water sheet is maintained over the paddy plot. Some shady zones are provided over the perimeter canal with twigs, hay, palm leaves etc., so that during summer heat, the fishes and prawns can take shelter and also hide themselves from predation.

Following summer fish crop, the salt water is completely drained out before the onset of monsoon. The rain water is allowed to was down the salt from the soil surface to the trenches, from trenches into perimeter canal, and finally to the estuaries through the sluice gate, during low tide period. The flushing operations are repeated till the soil salinity declines to nearly 4 m mhos/cm or less. To ensure better desalination, the top soil is scrapped

and made into small heaps on the soil surface. The practice accelerates desalination process during monsoon precipitation.

For the cultivation of kharif paddy in coastal saline soils, use of only nitrogenous fertilizers is generally advocated @ 60 kg N/ha in three equal doses at basal, tillering and flowring stages. During kharif no substrate for periphyton growth and shelter of prawn is necessary as the same is provided by the paddy plants. No ploughing, but simply tilling of the top soil, is required for paddy transplantation. Maintenance of low level of water during transplantation of paddy seedlings, also encourages development of lab-lab, which is made of algal species like *Lunbya, Anabaena* etc. and associated zooplankton in the matrix, which provide excellent feed material for freshwater fishes and prawns cultured with paddy.

Water management for summer shrimp culture

Plots are flushed with tidal water during full moon days, when the tidal amplitudes are maximum. Death and decay of algae bring down at times the D.O. level of pond water below 3 ppm, needing monitoring and correction. Feeding may be discontinued during such periods. By June end the water should be completely drained out, and the fishes and prawns harvested.

Water and soil management for simulataneous culture of shrimp with kharif paddy

Desalination process is carried out during July-August period depending upon the advent of monsoon. When congenial conditions of cultivation of paddy are restored, one month, old salt resistant paddy seedlings grown in non-saline seed beds are transplanted. A water level of 15 cm is maintained for the seedlings in the field. The coastal paddy is susceptible to attack of fungus due to high humid conditions (above 60%). To prevent infestation of pests, a mixture of 0.2% aqueous solution of Hinosan and 0.1% aqueous solution of Dimecron by equal volumes is applied @ 500-550 litres/ha, the first during initial phase, the second during growing phase, and the third during flowering stage. The associated prawn and fish population of the integrated system, has not been observed to be affected by such applications. During November the paddy is harvested.

When paddy seedlings have taken root by the end of August or by the begining of September, carp fingerlings are released into the plot along with juveniles of *Macrobrachium rosenbergi* (3 g size). No additional manuring of the soil is necessary for the fish crop. Usually rice-bran and GOC mixture (at 1 : 1 ratio) @ 2% of the body weight of the stocked prawn and fish is provided daily for favourable growth of stocked species. Only the rain water is maintained at the level of 15-30 cm depending on the nature and situation of the plot. Excess water is drained out through the sluice box during low tide.

After the harvesting of paddy, the main water cannot be retained beyond December, due to water loss through evaporation and seepage. Hence harvesting of freshwater prawn and fishes are required to be initiated soon after paddy harvest.

Yield and production rates

The summer fish crop of 3 months duration gives an yield of 400-600 kg. Of which 60% is *P. monodon* and the rest is mullet. During kharif, the production of prawn and fish harvested alongwith paddy is 500-600 kg/ha/3 months. Of these, about 40% is contributed by *M. rosenbergii* and the rest by carps. Thus from the two aquaculture crops, a total yield of 900-1200 kg/ha of commercially important fishes and prawns is obtained, besides a normal yield of 3000 kg/ha paddy during kharif. The total operation of paddy, shrimp and fish culture costs Rs. 22,000 and gives a net profit of Rs. 7,900 -.

3 MANAGEMENT OF PERENNIAL BRACKISHWATER IMPOUNDMENTS FOR SHRIMP CULTURE (BHERIES) — (WEST BENGAL MODEL)

The impounded fisheries in vogue through several decades in low lying areas in tidal mud flats, swamps, marshes, etc in the deltaic regions of West Bengal are known as 'bhasabadha' or bheries'. The general practice was to encircle the area by building low earthen embankments, after the land is cleared of mangrove plants, shrubs etc. Bheries are subjected to periodical flooding with tidal waters of salinity varying from 6 ppt to 32 ppt. Since the tidal range extends far inland in the rivers and their tributaries, a few bheries also exist in low and medium saline zones.

Location area, and size

Bheries are located in north, northeast and south in the deltaic regions of West Bengal. The bed level of bheries is 1 m to 3 m above MSL. The bed of bheries has a gradient towards the inlet channel which is connected in such a place that a maximum flow of tidal water carrying the young ones of shrimp and finfish find entry into the bheries.

The shape of bheries is mostly irregular. The sizes vary from 3 ha to 150 ha as a single water body. Total number of bheries recorded is about 1300 in the three brackishwater zones.

Design and construction

The bheries are chiefly large perennial water bodies surrounded by earthen dykes, which are constructed by borrowing earth from the trenches, excavated inside the bheries near the toe line of dykes. The height of dykes normally varies from 1.5 m to 1.8 m and the crest width is kept 60 cm. The side slopes of dykes are made 2 1/2 : 1 on the feeder canal side and 2 : 1 on the bheri side to make the dyke strong and stable. A gentle slope is provided in the bheri bed towards the sluice to facilitate easy ingress and egress of water. Inside the qheri a dyked channel of 1m depth and 2 m width is excavated just after the sluice box for easy filling and emptying the bheri. Inside the channel, split bamboo screens known as 'pattas' are fixed vertically in 'V' or 'W' shape to prevent escape of fish as followed in rice-cum-fish system in rice fields.

In addition, some shallow depressions are left in lower ringe areas where shrimps and fish can take shelter during fall in the water level in the bheri.

Sluice

The bheries mostly have single sluice which serves both the purpose of taking in tidal water during spring tide and releasing water from the bheri during ebb tide. The sluice is rectangular closed box type wooden structure, provided with wooden draw shutters on either end of the sluice box. The shutters regulate the flow and freely ply in the grooves in the frame of the wooden box. Sal wood is generally used as the constructional material. The sluice is fixed by cutting open the dyke and it is securely held in position, by consolidating earth on the sides and driving bamboo poles at ends. In bigger bheries hume pipes are also fitted at different places in the dyke, for quicker draining out of excess water for safety of the dyke.

Water quality of bheries

The water salinity of bheri generally varies from 0.15 to 9.5 ppt in low saline zone, 0.27 to 15.8 ppt in medium saline zone, and 6.60 to 36.2 ppt in high saline zone. pH of water fluctuates from 6.9 to 8.4. Dissolved phosphate concentration is higher in high saline bheri (0.24 ppm) than in low and medium saline bheries (0.09-0.11 ppm). The concentration of calcium (186.0 ppm) and magnesium (843.0 ppm) is strikingly higher in high saline bheri as compared to low saline bheri (65.0 and 153.0 ppm respectively).

Soil features of bheries

The bheri soils are generally silty loam and silty clay loam in texture, which are very retentive of water. The mechanical composition of soils is approximately sand 50%, silt 30% and clay 20% in case of former and sand 30%, silt 40% and clay 30% in case of latter.

Interestingly, available nitrogen status of bheries generally is low (15. 11 to 25.5 mg/100 gm), while bheri soils are richer in available phosphorus, more so, in high saline bheries (7.8 to 13.6 mg/100 gm). Organic carbon ranges from low to medium values (0.46 to 0.90% C).

Biological features

Benthic algae abundance varies widely in bheries under different saline zones. Their density is highest in high saline bheri compared to low saline bheries. The dominant forms of algae are generally *Lungbya* sp., *Oscillatoria* sp., *Spirogyra* sp., *Gyrosigma* sp. and *Navicula* sp. in high saline bheries, while in low saline bheries, these are represented mainly by *Nostoc* sp , *Anabaena* sp. and *Oscillatoria* sp. Among filamentous benthic algae, *Lungbya, Oscillatoria* and *Spirogyra* are of major occurrence in bheries.

Both worms and molluscs are abundant more in the medium saline bheries than in low and high saline bheries.

Management of bheries

The production system in bheries is largely based on trapping, holding and culture of wild seed of shrimps and fishes taken on the high tide. This traditional practice is giving way to selective stocking with postlarvae of

P. monodon and fry of mullet species like *M. parsia, M. tade.* etc.

Soil Management

After dewatering during November-December, the bed of bheri is expossed to sun till it cracks, so as to facilitate fast mineralisation of organic matter and improvement of soil quality. This helps in better growth of benthic algae, cheap natural food for fish and prawn.

Dyke maintenance

During November-December the bund all round the bheri is repaired and secured, so that it can withstand the tidal water thrust during season. The soil from the periphery of the bheri is dug out to strengthen the bund. The maintenance of sluice box is also attended to and channel inside the bheri in front of sluice box is deepend removing extra silt for ingress of water freely into bheri.

Water management

The water management is most vital and also highgly technical in this fishery to a great extent depends on proper manipulation of ingress and egress of tidal waters alongwith tidal phase, so that optimum water depth of about 1 0 1.2 m is maintained. The tidal water is drawn into bheri through the sluice in January-February for 3-4 days around new moon. Excess water from bheri is let out slowly during low level of neap tide to reduce the water thrust on bunds. Velon nets are fixed at the outer mouth of the sluice as well as on the 'pattas' on the front side.

Water level in bheries is over 1 meter in July - September period and is much less in winter months. The water management for ingress of seed and for shrimps harvest is same as followed for paddy-cum-fish culture system.

Erection of earthen compartment in bheries for nursery management

Direct stocking of young ones in bheries is found to lead to a low survival rate, less than 20-25%. Of late, an earthen compartment within bheri is erected for lower saline bheries. Prawn seed is stocked @ 5-8 lakhs/ha in these nursery enclosures and are reared for 10-15 days before they are released into main bheri by cutting the bund of nursery. In some bheries small pond and channels are made inside the bheri for being used as nursery grounds.

Fertilisation and feeding

In general, application of fertilisers and artificial feeding of fish and prawn is not resorted to in bheri management. Recently, however, some affluent farmers are applying organic manures like reicebran and oilcake (2 : 1 ratio @ 500-1000 kg ha and a low doseof fertilizer urea (40-50 kg ha). In addition, liming is done @ 100-150 kg ha in low and medium saline bheries for better growth of shrimp.

Harvesting practices

The method of harvesting is the same as described under rice-cum-shrimp culture (West Bengal model)

Fish and prawn production

The average production of fish and prawn in bheries, ranges from 281-3817 kg, 192-2376 kg and 277-3440 kg/ha/yr in low, medium and high saline bheries. *P. monodon* contributes about 8-39%, 17-33% and 7-14% in the above zonal production respectively.

General Observations on Farm Management Practices and Future Strategies for Shrimp Production in the Country

The country has at present 45,000 ha under brackishwater aquaculture largely practised in low lying brackishwater impoundments and paddy fields along estuaries and backwaters in the States of West Bengal, Kerala, Karnataka, Andhra Pradesh and Goa. Culture in pond-based brckishwater shrimp farm barring one or two, is a recent entry on the scene. The farm management practices discussed here include bheries and paddy fields utilised for rice-cum-shrimp cultivation and pond system.

The coastal deltaic paddy fields used for shrimp and fish cultivation and bheries are large units that range in size from a few hectares to 200 ha and as such they are suitable for extensive / semi-intensive culture practices. The water management practices largely depend on tidal cycle and tidal amplitude for water intake and drainage. The water depth is also decided by these parameters besides locations from estuarine lagoon backwater mouth, lattitude and season. The water exchange process facilitates nutritional elevation in soil and water, development of phytobenthos, aeration and draining of metabolites and waste products developed into the system from cultural operation. The management practice include exposure and raking of pond bottom to facilitate mineralisation of organic waste and bottom sludge. Entry of undesirable species is prevented by placement of bamboo screens or velon screen across the mouth of sluice gates or by conicad net infront of inside mouth of sluice. The West Bengal farmers are opting for two tier sluice system, the top sluice for intake of silt-free tidal water and the lower one for draining out of bottom sludge and metabolites. The farmers adopt various designs of field channels for effective distribution of tidal water across the whole field. The traditional system that depended largely on the tidal source of natural seed of shrimps and fishes is giving way to selective stocking. Seed trade based on natural seed collection has developed in recent years in West Bengal for *P. monodoon*. *L. Paysia* and *L. tade* to meet the seed demand of fishery operators.

In rice cum shrimp culture Kerala farmers follow rotational system with rice cultivation succeeded by shrimp cultivation. West Bengal has a traditional simultaneous culture of shrimps and fishes with rice, but here the shrimp and fish seed are taken into a net work of dyked field channels with high tide during February - June period and the dykes breached in August to enable entry of shrimp juveniles into main paddy fleld. This is intended to protect paddy fields from inundation of tidal water. This traditional system is now giving way to sequential system with rice cultivation

following shrimp culture in the paddy fields. The duration of shrimp culture in rice fields is 4 to 5 months while in bheries the duration of culture is 8 to 9 months. The bherie farmers are now installing nursery compartments within bherie to rear post larvae of penaeids for a fortnight before release.

The traditional system is cost-effective and energy - sparing and utilises natural productivity of soil and water and tidal energy as major inputs in the production system. The earthern dykes are developed by borrowing earth from the inner periphery of rice fields/bheries and the trenches and channels thus excavated facilitate even distribution of water across the field besides serving as shelter for cultural species. The sluice are made of local timber. The harvesting devices are pattas, traps and conical nets.

The production level with traditional system ranges from 400-3,000 kg made of fishes and shrimps, the latter in the range 250 - 500 kg/ha. Some of the highest production levels are recorded from bheries of West Bengal.

There is scope for improvement of traditional farm management practices to achieve a higher production rate of the order of 1 t/ha of shrimps. The alkaline saline soil are quite rich in inorganic phosphate in West Bengal. Application of ammonium-carrier nitrogenous fertilisers would further improve productivity. Rock phosphate are suited for acid saline soils of Kerala and other States on the west coast alongwith lime and nitrogenous fertilisers. *P. monodon* forms a small percentage in Kerala among shrimps cultivated in rice fields. Selective stocking of juveniles of tiger shrimp on a larger scale would further augment operetors' income and enhance country's export earnings. Stocking of juveniles of penaeids instead of post larvae should be encouraged for better survival and yield in large bheries and rice field system. *P. monodon* gives best yield in the salinity range 2 ppt to 17 ppt as reflected by abundance and growth of *P. monodon* in medium saline bheries of West Bengal. Supplementary feeding may be resorted to for smaller bheries and paddy field units used for shrimp cultivation.

Cultivation of shrimp in paddy fields in high saline zones of West Bengal and other States under high monsoon precipitations exceeding 1,500 mm rain per year merits consideration. The studies carried out by CIFRI for the past three years not show any adverse impact of such practice on soil quality in West Bengal. In the process single cropped coastal paddy fields will be put to optimum use by raising 3 crops, one of paddy, one each of shrimp crop with paddy and alone during summer. *P. indicus*, in addition to *P. monodon*, is suitable for culture under this system.

The brackishwater pond-based farm must be designed for intensive production of shrimps. This is a cost-intensive and energy-intensive producfion system based on seed, feed, water management, supplemental aeration or recirculation. The CIFRI has already achieved a breakthrough in seed production of *P. monodon* and *P. indicus*. Other research institutes and private sector agencies have also reported success in shrimp

seed production in this country. The Government of Maharashtra is soon commissioning a shrimp hatchery. These efforts would ensure a steady supply of quality shrimp seed. The CIFRI is presently engaged in shrimp feed formulation to achieve a production of 2 t/ha/3 months of *P. monodon* i.e. 4 tonnes/ha/yr. The result of feed trials will be known in a year or two. Similar production levels appear to have been achieved in Japan, Taiwan and Philippines, with cost of production varying from $ 5 to 6 per kg of head-on shrimps. The possible margin for shrimp farm operators and exporters under such high production cost levels under Indian conditions may be a factor to reckon with

The return on investment of shrimp (and fish) culture computed by Indian Institute of Management, Ahmedabad is of the order of 73% for traditional (filtration) system and 41% for extensive culture. It is as high as 82% under intensive culture in experiments conducted by CIFRI.

The country has at present 45,000 ha under brackishwater aquaculture practised in bheries and paddy plots along estuaries and backwater. Another 30,000 ha can be added to this area. These together can generate a production of 50,000t of shrimps @ 1t/ha with improved management practices for bheries and @ 500/kg/ha in paddy cum shrimp culture system. In addition 10,000 ha could be brought under brackishwater shrimp farms (pond-based system with an yield rate @ 2.5 t/ha in 2 crops under intensive culture generating another 25,000 t. A production of 75,000 tonnes of shrimp from brackishwater aquaculture is an achievable target during the next 10 years. This of course, implies effective support services including seed supply, credit and extension.

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PRESENT STATUS OF TECHNOLOGY ON COASTAL AQUACULTURE ENGINEERING IN INDIA

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1. Introduction

1.1 Technology in any field is the application of proven scientific techniques in practical or industrial art and not just the techniques, normally construed as technology, Technology in aquaculture engineering is still in the developing stage and trouble-free aquaculture farms based on sound techniques are yet to be grounded in india. Thus, the technology on aquaculture engineering is not yet available in India.

1.2 Aquaculture engineering covers site selection, arriving at the correct datum from tidal data, layout planning of economically viable functionally operative farms with proper water management and design of bunds and sluices. Sound techniques with regard to the above are available wlth the Central Institute of Coastal Engineering for Fisheries but are yet to be tested in the field as the projects designed by the Institute are still under construction.

2. Selection of Site

2.1 Selection of a proper site is the most important aspect in having economical and functional farms. The different techniques of aquaculture engineering are discussed below :

2.2 Procedure for Site Selection:

2 2.1 Desk Study

Before selecting the site for a brackish water fish farm, a thorough study of relevant toposheets (to a scale of 1:5,000) and the Admiralty Chart of the area concerned should be made. The Study will reveal the areas available between low water and high water springs for siting a brackishwater fish farm and also indicate whether any big rivers flood in to the area. Whether the area is highly sandy or full of of vegetaion etc. from the indication given therein. From a detailed study of the same, the area actually available and likely to be suitable can be marked out and that area may be visited for further examining the suitability of the site, The Admiralty Chart also gives the tide levels for a site nearby and that can be noted while visiting the site.

2.2.2 Field Study

The area found suitable from the

desk study should be reconnoitred and the following information should be collected:

(a) Whether the area gets inundated by floods, storm Surges, if so the maximum height of water that comes over the area and the highest high water level experienced over the area in the past may also be ascertained from old residents near the site;

(b) The height of water over the area that occurs during the normal spring high tide;

(c) How far the low water goes below the general ground level of the area during normal spring low tide ?

(d) How thick and high are the mangroves or other vegetation and the type of mangrove vegetation growing in the area ?

(e) Type of soil, whether sandy, loamy, clayey or silty ?

(f) Whether the area is flat or gently sloping or steeply sloping towards the creek may be noted. Approximate gradient of the ground may also be noted;

(g) Water samples and soil samples at surface and a metre or two below may be collected for testing chemical and engineering properties;

(h) Enquiries may also be made as to whether any effluents discharging from any factory join the creek and if so, the nature of effluent and whether it is pollutant free;

(i) Whether the site can be easily approached, if not, the length of approach road required, the number of bridges and culverts that may be required ?;

(j) The species that can be cultured, availab.lity of seed and the prices at which it can be obtained at the site;

(k) Availability of contractors for construction and cost of labour;

(l) Availability of fresh water, its quantum and source;

(m) Availabilty of ice and its cost;

(n) Cold storage facilities available nearby; and

(o) Availability of electricity, diesel and their costs.

3. Arriving at an Appropriate Datum

3.1 Computing an appropriate datum from tidal data is the next most important aspect of aquaculture engineering, as

all water, pond and channel bed levels are to be arrived at with reference to that datum for efficient water management and design of economical fish farm.

3.2 The datum and the tide levels for a site can be arrived at by transfer of datum from the nearest standard port. In order to correlate the tide levels with that of the nearest standard port, the spring high water, near new or full moon, at the site is observed and computed with refrence to the high tide on that day for the standard port by referring to the Indian Tide Tables. The mothod of computing the tide level at the site, by above method is illustrated below.

(i) The nearest stanard port "A" is about 200 km. south of a site surveyed at a place "B". The spring high tide levels on 12.4.79 at the standard port and the corresponding high tide levels at the site on that day with respect to an arbitrary datum chosen were;

	Standard Port "A"			Site "B"		
Date	Time in hrs	Tide level	Tidal range	Time in hrs	Tide level	Tidal range
12. 4. 79	02 13	00.07	00.97	02 50	00.18	00.79
	08 25	01.04		09 00	00 97	

(ii) The datum correction equal to the difference in high water levels between "A" and "B" for that day is applied, so that the high water levels at both the places are same. In other words the datum of "B" is reduced by (1.04 - 0.97) 0.07m. Now, the Mean High Water Springs at "B" with respect to the corrected datum can be taken as that of "A". Since the datum has been fixed by comparing high water levels of the standard port and the site, there is no need to apply any correction for MHWS, but for arriving at other tide levels at the site "B" a range correction will have to be applied. The tide levels at "A" and the corrected tide levels at "B" along with the correction calculations are given below:

Tide levels	For "A" (in m)	Corrections	For "B" (in m)
MHWS	1,15		
MHWN	0.84	(1.15-0.84)0. 79 0.97 = 0.25	1. 15-0 = 1.15
MLWN	0.43	(1.15-0.43)0. 79/0.97 = 0.59	1. 15-0. 25 = 0 90
MLWS	0.14	(1.15-0.14)0. 79/0.97 = 0.82	1. 15-0. 59 = 0.56
			1. 15-0. 82 = 0 33

The above method of transferring the datum should be done based on the high water levels during the spring tide of a fair weather day only, in order minimise the errors due to abnormal weather conditions. Further, the nature of tides (i. e. semi-diurnal or diurnal) should be same at both the site and the standard port.

4. Survey and sub-soil Investigations

4.1 There is no need to explain the sub-soil investigations required for an aquaculture project, because it would be very much similar to other engineering surveys. However, I have to mention here that triangulation with theodolites should be done in case of brackish water fish farm surveys as they involve large areas and mapping of the survey should be done with reference to the coordinates, either local or geographical.

4.2. With regard to sub-soil investigations, some very simple field investigations may be conducted, including collection of undisturbed samples, for testing of engineering properties. The methods are explained below.

4.2.1 Probing

Probing is a method of establishing the general nature of soil by resistance offered by the soil to the penetration. The results of probing should always be confirmed by conducting soil tests on the samples collected at the representa tive places. Probings can be made with the help of steel or wooden rods fitted with sharp metal shoes and by driving the rods with a sledge hammer. The number of blows required for 20 cms. penetration indicates the nature of the soil.

4.2 Sampling

A 50 mm dia 600 mm long P.V.C. pipe can be slowly pushed into the soil and the soil surrounding the pipe be carefully removed without disturbing the pipe. At the bottom of the pipe the soil can be cut with a thin wire to release the pipe, with the soil intact inside the tube. The ends of the P.V.C. pipe should be sealed with plastic sheet to prevent and loss of moisture.

5. Procedure for Planning Economical and Functional Layout for Efficient water management

An economical and functional layout is very important for successful operation of a farm. The following procedure may be followed.

(a) Study the contour survey map with reference to the relevant toposheet and admiralty chart of the area and the soil conditions. Avoid sandy, thick mangrove forests and highly slushy areas.

(b) Mark out the probable suitable boundary and try to make the area more squarish by cutting down the inconvenient corners, loops and pockets and run the boundary of farm on high ground level, as far as possible.

(c) Find the source from where the main supply channel can be taken and site it in the deepest area to reduce the quantum of excavation.

(d) Draw a rough layout for the farm, channels and ponds, and work out the level of ponds and channels, with reference to the datum such that the type of water management required for the farm is achieved.

(e) Calculate the earthwork quantity involved in excavation and formation of bunds and see whether they match.

(f) From the above an idea will manifest as to whether by altering or reorienting any saving in earthwork in excavation and bunds can be made, and how best they can be matched to economise on earth work.

(g) Make a new layout on that basis and estimate the quantity of earth work required for the new layout. If this gives further ideas to economise, do economise and try a few more layouts till you find one that is most logical, functional and econonitcal.

6. Designing of Economical Structures

6.1 Normally many of the engineers, in particular, those from the Irrigations and Buildings and Communication Departments of Public works go about designing the structures and sluices as per standard P.W.D. norms and sometimes the structures get over-designed and become expensive for the functions they have to perform. For example, bund widths for channels and small dams are kept adequate enough at top for one-lane traffic but this is not required for a culture farm except in case of periphery bunds, if a vehicle has to move, but definitely not required for the inner bunds. Along the inner bunds, only a fish farmer would be movnig about with a push-cart and for this purpose, the top width need be only 1 to 1.2 m wide. Many of the private fish farmers manage even with only half-a-metre, because the thinner the bunds, the larger water spread area he gets for farming and less investment he makes in earth work.

6.2 It is quite often seen that bunds sink considerably and bed of the pond raises The scientists would be complaining that the bunds have silted and water depth is coming down for culture. If one analyses this carefully this reducing of depth of water in the pod is not much due to siltation but more due to heaving up of pond bed due to the load from the bund. In soft clays, any additional load put on them causes slip failures and result in sinking of bunds and upheaval of pond beds. In order to avoid this situalion, it is necessary to give berms on either side of the bunds which not only balances the overburden of the bund but also serves as a platform for the farmers to get down and inspect the pond and also gives more area for growh of Lab-Lab and Benthos on which the fin-fish and prawn survive.

6.3 Similarly in cases of sluices, many heavy structures are constructed to take the earth pressure of the bunds and increase the load on soils. If a proper design analysis is made the thickness of the wing walls can be brought down considerably, because the 3 sides of the sluice adjoining the bund would almost act as a container and the earth pressure towards the sluice opening is compensated to some extent

by the earth pressure on the wing walls on the sides and thus requires less thick wing walls.

7. Conclusians

7.1 It is rather difficult to identify every single aspect to economise but intelligent application of knowledge, courage in designing and the will to make an effort to make the structures and the farm as economical as possible would go a long way in designing the most economical, functional and operative farms.

7.2 The biggest requirement for an engineer to apply his mind and design a really economical and functional farm is the identification and indication of all the requirements by the biologists in clear and unequivocal terms at the outset. If requirements are indicated at different stages of designing or construcation, it becomes difficult to adjust and some important functional aspect may be overlooked or lost sight off. Many times it is advantageous to have continuous dialogue between engineers and biologists at each stage of planning and designing and prepare a check list, so that the engineer can strive to plan an economical and functional farm. The biologists also have to remember the more sophistication they ask for and more avoidable conditions they stipulate more expensive will be the farm, making it not viable.

7.3 The CICEF has done its best, based on the information and the requirments given by the biologists, and designed the farms at Asangoon, Chorao, Thondiakku, polekurru and Karukalacherry. These are under construction and once they are grounded, any engineering shortfalls will be available for review by the help of which the aquaculture engineering techhology can be perfected.

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TRAINING IN AQUACULTURAL ENGINEERING ITS NECESSITY AND FORMULATION

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Indian Institute of Technology, Kharagpur

India has practised production of fish by culture from by-gone ages but cultivation of aquatic animals in true sense started in the country only about four decades back. The food problem viewed with growing population and limited land resources points to the need for harnessing the aquatic resources to meet the requirements of food in quantity as well as quality. The country has vast water areas which may be put into use for cultural production of fish. There are about 25 lakh hectares of fresh water tanks and reservoirs and about 15.3 lakh hectares of estuarine and brackish water swamps which may be developed for fresh and brackish water fisheries. The development of brackish water aquaculture for supply of prawn to sustain our export trade in marine products has assumed particular importance in recent years. The report of the Task-Force on Marine Products (1982) states "Prawn is major item of our marine products export. In 1981, it constituted 72.76 percent of our export in quantity and 86.9 percent in value. The demand for prawns has been steadily increasing all over the world. However, the producton of prawn from the sea has reached a stagnation point and cannot be expected to increase much more unless new grounds are located. In this context inland brackish water prawn culture has attracted attention as potential area for increasing production. In recent years, countries like Equador, Panama, Philippines, Thailand, Taiwan, Japan etc. have been laying a lot of emphasis on increased production of prawn by aquaculture practices. "Besides prawns, brackish water aquaculture is being harnessed at present to produce other aquatic animals of high commercial value both for export as well as for internal markets in many countries in the world.

For aquacultural production of fish to be economically and commercially viable, the system has to be efficient and cost effective. Planning, designing and operation of aquacultural systems have generally been left in the hand of fishery biologists supported by chemists. There is no doubt that substantial progress has been made in aquacultural production under such management but the demand for greater efficiency and economy has revealed many deficiencies in such an arrangement. Such deficiencies have been particularly noticed in coastal aquaculture. Dr. K Kuronuma, Ex-President of Tokyo University, Fisheries and one of the internationally recognised experts in aquaculture observed : "Engaged to the works of aquaculture and conservation

of aquatic animal resources for a quarter of a century in terms of biology and fisheries technology, I have a deep impression that implementation of actual works has been placed eventually in the hands of fisheries specialists with background of biology and/or chemistry. The results brought up under the conditions are showing unforunate lacking of critical points which escaped from the attention of these specialists. The fact is more often discovered especially referring to the constructian of various sorts of facilities attached to the aquaculture projects established along the sea coast. In short, those facilities would have better provided to meet the objective in terms of efficiency as well as economy if there were more appreciation and application of the technique developed in civil engineering and mechanical engineering .... I feel quote confident that the improvements on pond facilties and water management if made by the adoption of engineering techniques in cooperation with biological and/or chemical sciences will bring forth the up-rising and stablization of fish production in pond". There is an urgent need for the services of technical persons who could combine the knowledge in biological sciences with application of engineering principles for commercial production of fish by aquaculture. The new disciples of aquacultural Engineering has emerged as a branch of engineering and technology related to economically efficient and technologically justifiable methods of utilisation of inland, coastal and marine water resources for biological production of commercial value.

Aquacultural Engineering has been defined as application of engineering principles in production of aquatic living matter under optimum conditions as far as economically justifiable and harvesting, processing, preservation and marketing of the produce. Aquacultural engineering is by its definition a multidisciplinary subject drawing upon the knowledge of civil, mechanical and chemical engineering naval architecture, scientific disciplines of fishery biology, bio-chemistry, physics and also social and management sciences. Teaching programme in Aquacultural Engineering requires a striking balance by judicious incorporation of the relevant principles and practices in different disciplines of science, engineering, technology and social science with a view to equipping the graduate with the requisite knowledge for harnessing the aquatic resources of the country to the best advantage. There has been considerable amount of discussion on the name to be given to this new discipline in engineering and technology. While the Japanese fishery scientists and engineers have preferred the name 'Fisheries Engineering' of which 'Aquacultural Engineering has more advocates. As in this country, culture of fish and prawn in fresh, brackish and marine water will receive emphasis in future, it is considered desirable that new discipline should be called 'aquacultural Engineering" Although the main emphasis on a course in Aquacultural Engineering, designed in relation to requirements in our country, should be on the design, construction and maintenance of aquacultural facilities including ponds with embankments, water supply and drainage facilities, control

arrangements for movement and distribution of water to the ponds, assurance of required volume and depth of water in the ponds, and of water quality, the harvesting and post-harvest handling of produces would also require attention.

Aquaculture farms have a large component of civil engineering work. Hence it has often been put forward that civil engineer would be quite competent to deal with engineering aspects of aquacultural systems. However, as the commercial production of aquatic animals and plants is tne raison d'etre of the aquaculture enterprises, biological as well as intricate socio-economics problems are interwoven with engineering aspects in successful construction, operation and maintenance of aquacultural farms. Hence one Aquacultural Engineer must not only know the relevant engineering principles and techniques but has also to apprcciate the biological implication of these in production as well as harvesting and processing for market.

Engineering and technological education other than agricultural technologies are supervised and monitored in India by the All india Council of Technical Education under the Central Ministry of Education. Hence the programme of teaching in Aquacultural Engineering will have to follow the norms set by the AICTE. The first consideration in introducing a course in Aquacultural Engineering is the academic level at which this is to be introduced. Indian Institute of Technology, Kharagpur, had this matter discussed at a meeting of experts and persons connected with development of aquaculture and fisheries in this country. It was noted that a student pursuing the undergraduate course in civil or agricultural engineering do cover a significant portion of the basic engineering principles and their application which are relevant to aquaculture engineering and four year course leading to Bachelor's degree in Aquacultural Engineering may not be justified at the present state of development of aquaculture in the country and consequent job potential. It was recommended at the meeting that since aquacultural engineering will be a specialised engineering course it should be offered as a post-graduate course to students already having a degree in Civil or Agricultural Engineering A degree in Naval Architecture or Chemical Engineering could also be considered as qualifying degree for admission in the course under certain circumstances. Aquacultural Engineering should be introduced at undergraduate level only as an elective subject in the final year of the undergraduate programme.

The post-graduate courses in enginering and technology have now to conform to the recommendations of the Nayudamma Committee which have been accepted by the Central Government. The course curriculum to be of 3- semester duration (1 + ½ year) of which the first two semesters will be devoted to the course work and seminar while the final semester will be entirely used for working on a project related to the field of specialisation. The students are to be admitted in the course at an All India Competition on the basis of their performance at the Graduate Aptitude Test Examination (GATE) conducted under

the auspices of the Ministry of Education. Candidates sponsored by Government (Central & States) organisations and undertakings as well as those recommended by development agencies may be admitted without going through GATE. All admitted students except the sponsored ones will receive a studentship of Rs. 1000/- per month for the prescribed duration of the course.

In designing a course in Aquacultural Engineering in India one has to proceed without having the benefit of previous experience as no such course had been offered in the country in the past. The designed course has to take account of the realities of the situation in the country. In the present state of development of fisheries in general and aquaculture in particular narrow specialisation in a specific aspect of aquaculture may be counter productive while at the same time the engineer appointed in fishery establishments must have sufficient knowledge in the special field to be effective in economic planning of efficient aquaculture system To find a reasonable balance between different factors, the Aquaculture Engineering course at IIT was designed on the principle that half the credit in the course of instruction should go to core subjects which would give the students necessary basic knowledge in planning and designing as well in construction, operation and maintenance of aquacultural systems in different hydrologjcal situations as well as fundamentals of fish harvesting and processing. The second half of the course will be devoted to elective subjects wherefrom student may choose the courses which help them gain special knowledge in selected areas. The third semester of the curriculum will be devoted to project work, where a student will have to make a comprehensive study of engineering aspects in an area of research and development in aquacultural production of fish and shell fish having immediate practical applications. The course curriculum and syllabus for the M. Tech. course in Aquacultural Engineering are given in Appendix. As Aquacultural Engineering is a new and growing subject, the curriculum and syllabus will require regular assessment, modification and updating: The comments from the scientists, engineers and technologists as well as from those in charge of management of aquacultural system will be helpful in improving the relevance and effectiveness of the course to meet the requirements of the country.

Aquaculture in India presents a complex picture as it ranges from fresh water to different ranges of brackish water and then to lagoon and marine water. The different eco-system requires varying degrees of sophistication in engineering applications. Hence, course of study in aquacultural engineering must address itself to the needs of aquacultural system as at present as well as those which may arise in near future due to technical and economic developments in the country as well as to some extent, in other countries because as in the case of prawn, our production will have to take into considerations the export demands and cost of production.

1) 12641 Head Water Hydrology (3-0-3 4)

Precipitation-intensity, duration, distribution and frequency of typical storms; analysis of storm data at a point and in an area; run off a function of precipitation, infiltration, evaporation, surface detention and storage; stream gauging run off hydrographs; unit graph theory and practices as applied to small watersheds and its limitations; flood routing theoretical and graphical methods of routing through reservoirs and retarding basins; land capability classification, principles of land use planning; conservation management of arable and waste land; overland flow and mechanics of erosion; methods of head water flood control sedimentation and its control; aerial photographs in watershed planning; evaluation of conservation works.

2) 12642 Conservation Structures (3-0-3 4)

Design of bund and terrace systems in arable lands; design of temporary and permanent gully control structures; design of small dams for head water flood and sedimentation control, typical spillways and their design criteria.

3) 12652 Irrigation Equipment Design

Water lifts operated by human and animal power; design of don, persian wheel and chain pump; positive displacement and turbopumps; steady state analysis; derivation of low and torque equations; optimization of efficiencies, experimental determination of performance coefficients, design of radial pump, testing of pumps and analysis of data; 'Selection of pumps; dsign of farm irrigation distribution system and its optimiztion. Application of feed back system for control of water.

4) 12661 Hydrology and Management of watersheds (3-0-3 4)

Meterorology, Hydrologic cycles, ET, Infiltration, Interception, Depression storage, Delineation of small watershed; Rainfall Runoff relationships, Methods of runoff estimation from small watersheds, Unit hydrographis; Different conservation practices-Biological, Mechanical and Structural-Their effects on Watershed behaviour, surface storage, basin recharge, and agricultural and forest development; stream and sediment gauging; Grass-1 and improvement; Socio Economic changes; Quantitative evaluation of management techniques. Statistical analysis of hydrological data, Flood frequency analysis.

5) 12666 Water Resources Systems Analysis

The nature of water resources systems. Systems analysis - The jargon used. The methods of systems analysis. Linear Program Models - Concept of Simplex Tobleau, .its working principles - the two phases of simplex method - Revised simplex method-Duality Decomposition principle-Post optimality analysis. Transportation problem. Nonlinear programming of simple cases. Dynamic programming

Multistage decision process - Computational procedure in Dynamic Programming. Basic concepts of probability - Stochastic Linear and Dynamic Programming - Application of Systems Analysis to Water Resources Systems in particular.

6) 12675 Land Grading & Earth Moving Machinery (1st Sem - Elective)

Grading of slopy lands. Design and principles of mechanisms of crawler mounted tractors. Dump trucks and their mechanisms. Load hoisting equipments. Moving the earth operating members. Earth diggers, ditchers. Digging resistance and its theory. Land clearing. Bull dozers, scrapers, elevating graders self powered graders. Optimizarion of earth moving and grading machines. Boring machines. Different methods of boring tube wells.

7) 12678 Instrumentation and Research Techniques (2nd Sem - Elective)

Application of measurement principles to Agril. Engineering experimentation; measurment of physical, rheological, mechanical, electrical, flow and aerodynamic properties of Agricultural materials. Measurement of temperature, Pressure, humidity, moisture content, bulk density, velocity discharge, rainfall, sunshine and evaporation.

8) 12681 Fishery biology and Fish culture techniques

Classification and external morphology of fishes, crustaceans and molluscs in respect of commercially important species. Food and feeding habits, growth aging and reporoduction. Techniques of induced breeding of fish and shell fish. Bund breeding - dry and wetbunds Hatchery techniques. Monoculture and polyculture. Prawn culture. Pearl culture Composite fish culture. Mariculture. Cage culture.

9) 12682 Unit operations in Aquaculture Product Processing

Causes of spoilage of fresh fish and methods of prevention of spoilage. Transport of wet fish : containers and packages, Methods for transport; icing of fish; different forms of ice and their application in fish transport. Insulated and refrigerated transport vehicles.

Cold storages : design, construction and maintenance of cold storages for wet fish.
Principles and applications of preservation techniques; refrigeration, heat-treatment, curing and dhydration.

10) 12683 Planning and designing of aquacultural projects

Aquacultural Project site; water supply, soil type, topography, drainage, computations for water requirement, seepage and evaporation. Seed availabilty. Environmental considerations, tidal effects, effects of flood and cyclone. Requirements of manpower, energy and equipments. Proposed cultural practices and calculations for expected productions. Market study evaluation of economic

viability of the project. Society and social benefits. Project layout. Types of ponds and their designs. Flow scheme for water sppply and drainage. Flow channels design. Inlet and outlet structures.

11) 12684 Design of Aquacultural Facilities and Epuipment

Fish and Prawn hatchery; Supply of fresh and sea water; circulation of water, temperature control; aeration facilities; Breeding tanks; incubators; spawneries; Breeding tanks; fish raceways - earthen and cemented with and without water recirculction systems; Biological filters, mechanical filters. Fish ladders and fish lifts, storage facilities. Watch and ward structures. Aeration equiqments : air-compressors. Pumps. Automatic feeders and demand feeders. Weed control equipments. Fish cages.

12) 12685 Design of fishing gear

Classification of major typse of fishing gear; hydrodynamic forces and hydraulic resistance equilibrium configuration and shape; fishing depth; configuration in relation to fish behaviour; location of kites; placement of floats and sinkers; assemblage of nets; specificarions of webbing. Gear materials : natural and synthetic fibres, Terminology and numbering systems. Type and size of twine knot preservation.

Mechnical studies on underwater operation of fishing gear and measuring instruments for the purpose. Model testing. Fishing methods : attraction of fish by use of ligh electrical fishing.

13) 12686 Operation of fishing crafts

Important types of fishing boats use in inland waters as well as fo seafishing.

Materials of construction of boats Wood, steel, fibreglass reinforce plastics, ferro-concrete, etc.

Essentials in hull design and constu ction of fishing boats. Influence o factors such as physical ane geo graphical conditions in the area o operations, nature of coast line nature of fishery; distance of fishin grounds from the operational base species of target fish and fishin method and gear to be used.

Engine types and machinery installa tion; Requirements and arrangement for storage and processing of fis on board. Maintenance of fishin boats.

14) 12687 Aquacultural Engineering An alysis and Quality Control

Formulation of mathematical model for aquacultural operations. Develop ment of analytical and numeric techniques for solving such model Methods of generation and pred ction. Reliability of estimates, line regression analyais - and nonline regression analysis. Design of e periments. Dimensional analys Similitude studies. using computa ional sub-routines. Quality contr of Aquacultural products.

5) **12688 Operations Research in Aquaculture**

Integration of aquaculture with dairy, piggery, poultry and duckery, Integration of aquaculture with agriculture and horticulture such as paddy-cum-fish culture and fish culture with silk worm paupae. Economic analysis and advantages of integrated aquaculture. Sewage-cum-fish culture. Fish culture by recycling of aquatic weeds.

16) **12689 Open Channel and Tidal Hydraulics**

Uniform and gradually varied flow - Flow profile analysis spatially varied flow - control sections - delivery of canals - design of transitions - rapidly varied flow - hydraulic jump - rapidly varied unsteady flow - surges in canals.

Definitions - equilibrium theory of tides - tidal propagat on in channels, estuaries and coastal inlets - sediment transport and deposition.

17) **12690 Pollution Control and Waste Utilization (3 - 1 - 0)**

Types of industrial and domestic pollutants their sources, effects and transmission. Water pollution in rivers, lake reservoirs, estuaries and coastal waters. Conventional and advanced waste water, treatment techniques. Recyling of industrial and domestic waste water. Waste utilization to aquaculture - use of sewage water, cattle waste and poultry waste growing aquatic animals like fish and shrimp.

18) **12692 Processing and preservation of Aquacultural products**

Selection of site and plant layout for a processing factory (canning, freezing and dehydration).

Fish handling and processing equipment, sanitary construction of such equipment; materials of construction. Preservation by freezing canning, curing and dehydration of commercially important varieties of fish and shell fish.

Quality control and quality assurance in fishery products.
Fish protein concentrate and fish meal. Fishery by-products.

19) **12694 Costal Hydraulics for Aquaculture**

Classification of waves - significant wave height - wave energy - reflection, refraction and defraction of waves - design break waters - sediment transport due to waves - beach erosion - equilibrium beach profile - littoral transport - coastal protection works for aquacultural farms.

20) **16624 Principles of Foundation Engineering**

Introduction, Planning of foundations, Bearing capacity of soil, Settlement computation for foundations, Principles of design for spread foundations, Roft foundations, file foundations, Foundation failure, Problems.

21) 25653 & 25654 Numerical Analysis (3- 0-0) 3

Approximation, errors, interpolation divided difference; Newten's formula, Laugranges interpolation formula, numerical differentiation and integration; Newton-cotes formulae, Newton's forward and backward difference formulae; central difference formulae; numerical solution of differential equations, Rungekuta method; method of least squares numerical solution of equation; Newton - Raspson formula; Gauss seidel interation and relaxation; determination of inverse of matrix; variational methods, Rayleigh Ritz method and Gabriks method; method of finite differences; hermosic analysis.

22) 25657 Engineering Mathematics (3-1-0) 4

Tensor Analysis : N - dimensional space, Summation convention, contravariant and covariant vectors, invariants, second and higher order tensors, addition subtraction and multiplication of tensors, quotient law, symmetric tensors of second order, Christoffel symbols, transformation of christoffer symbols. covariant differentiation of tensors.

Special Functions : Orthogonal set of functions hypergeometric, Hermite and Laguere and Greer's functions, sturm-Liouville problem.

Integral Transforms : Introduction, Formal development of the complex fourier transform, cosine and sine transforms, transforms of derivatives, applications of transforms to L.U.P. for partial differential equations.

Conformal Mapping : The geometrical representation of functions of Z, Conformal mapping, bilinear transformation, Schwarz- Christoffel transformation

Calculus of Variation : Introduction, Enter Lagrange equation, Constrained extremals, boundary conditions, Method of approximation (Rit = Z ÷ method).

23) 29615 Fisheries Naval Architecture

Fishing vessels - specialities over other ships of similar size; various types of fishing vessel, stability in various conditions of operation; icing; precaution against loss of stability; IMCO regulations for fishing vessels, general arrangement; fish hold - its location and insulation; free board; deckmachinery; net spreading and hauling system; elements of design of fishing vessels power requirement for inward / outward voyages and during traveling and methods of fishing section of marine engine. Location of processing plants on factory ships.

24) 52610 Operations Management (3-1-0)

Models of production systems, decision making, planning analysis and control. Design of production systems, Capacity planning, Product development, job design, Motion and time study, Plant location and layout production planning and control, Basic inventory models. Quality Assurance.

COASTAL AQUACULTURAL ENGINEERING FOR DEVELOPING PRAWN FARMING WITH PARTICULAR REFERENCE TO SUNDERBAN REGION

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Introduction

It is estimated that the Coastal belt of West Bengal has about 0.8 million hectare of saline area spread over in the districts of 24 Parganas and Midnapore. Of the total coastal saline areas in West Bengal about 90% constitute the saline soil belt of the district of 24 Parganas coverd in Sunderban region.

Most of the prawn farms in the Sunderban region of West Bengal are located in the areas of low-lying tidal mud flats in the estuaries within tidal range and subject to tidal inundation. These lands are subject to tidal flooding to a depth of 1 m or more during spring tides and are fully exposed in low tides. These lands are suitably utilised for brackishwater fish farming by encircling the land with stable dyke, water regulatory gates and inlet channel.

Selection of site

Selection of a suitable site for prawn farming is of paramount importance since this factor largely decides the cost of farm construction, its economic viability and success of the farming project. Hence before undertaking the construction of prawn farm in the deltaic areas, detailed enginering survey is undertaken at the site on the following aspects-

i) Nature of the estuarine area

ii) Shape and size of the land

iii) Topographical characteristics of the land

iv) Elevation of the land in relation to MSL

v) Land contours

vi) Tidal fluctuations

vii) Soil and water characteristics

Topography

Though the prawn ponds can be constructed on any terrain, the land surface conducive to provide gentle gradients in one or two directions are usually the most favourable. Gentle bed slopes with gradual fall towards the adjoining estuary provides good location for a farm.

Soil cover

Dense forested areas covered with large trees or mangroves should as far as possible be avoided since it involves additional expenditure on clearance and felling of trees. Left over tree stumps spoil the ponds and dykes and pose continuous maintenance problem.

Soil characteristics

The soil in the deltaic region is predominantly silty or silty-clay in nature with small percentage of sand. The soil in general is water retentive but has poor consistency and low bearing capacity to support heavy load. The mechanical composition of soil studied in a soil profile upto 2 m depth from the ground surface in lowever Sunderban region indicates - sand 23%, silt 42.4% and clay 34.6% with loamy in texture. Soil pH ranges from 7.2 to 7.5. Soil with larger content of sand (more than 70%) although have higher bearing capacity but are unsuitable for construction of pond dyke owing to susceptibility to erosin by wind and rain. Similarly soils of newly formed islands in the estuary are not safe because of softness and poor consistency.

Elevation and tidal amplitude

Elevation of the land in relation to the adjoining flowing system and the topography of the area is properly mapped by undertaking detailed contour survey at the site. In relation to a fixed bench mark the contour lines indicating the rise and fall of the land are properly delineated.

The ground elevation of most of the prawn farms varies from 0.80 m to 1.50 m. In case of prawn farms the tidal inundation is the major source for water supply. Therefore one of the main determining factor for selection of the site is the amount of possible submergence of the farming area due to tidal rise and whether such submergence will afford optimal water depth in the ponds taking in to account the losses due to seepage and evaporation. The tidal amplitude in delt aic West Bengal is in the range from 1 m to 5 m. The wide variation in the tidal amplitude facilitates effecient water replenishment in the ponds in all the tides. Tida floodings on the land is recorded round the year to determine the depth of pond excavation, dyke height, level of inlet channel, location of sluice gates etc. This is done by fixing a graduated vertical staff gauge at a place of known elevation in relation to MSL and tida, rises are recorded at 5 minutes interval during the tidal phases.

Layout and design

The layout of prawn farm ponds is primarily based on topographical characteristics and tidal fluctuations at the site. Most of the deltaic islands in the Sunderbans have the land topography in the shape of an inverted saucer. The central part of the island is generally at higher elevation and the rest land gradually slopes down to lower elevations adjoining the estuary. The low lying fringe areas are suitably utilised for construction of larger ponds for copious supply of water and to maintain desired salinity range leaving atleast a clear margin of 50 m of mangrove forest belt for safety of the farm against tidal thrusts.

The prawn farm complex consists of supply channel with one or two manually operated head sluice gate, nursery ponds, stocking ponds, perimeter dyke, partition dyke between the ponds and independent inlet cum outlet (inlet in high tide times discharges the function of outlet in low tide) for the ponds. The ponds are arranged in parallel rows on both sides of the feeder channel to facilitate independent filling and emptying as and when required. The ponds are all well defined, rectangular in shape and considerably longer than their width to maintain dynamic flow energy in the system. It has been suggested that brackishwater ponds have to be filled with water to a minium of 40 Cm to get satisfactory production. However, for Indian condition the most ideal production can be achieved if about 90-120 cm of water depth is maintained in the ponds. The usual specifications of prawn ponds are as follows –

Pond	Area	Water depth
Nursery	0.03 - 0.05 ha	30 - 40 cm
Stocking	1 - 2 ha	90 -120 cm

Pond beds are given gentle slope towards the inlet for easy filling and quicker dewatering under gravity.

Silt trap

Siltation is a major problem in tidal estuaries which pose a big threat to the life of shrimp farm and make the farming practice uneconomic. Silt ingress to farm ponds can be effectively reduced if detention basin or silt trap is constructed in the farm at the end of the main sluice. The silt trap is in the shape of a trapezoidal pit which is constructed in the bed of the feeder channel with sides either brick lined or protected by stone pitching. An appoximate idea of the length of silt trap can be ascertained from the velocity of tidal flow in the channel and the sizes of the sediment particles in the flowing water from the consideration of the fall velocity.

Feeder channel and pond

The bed of feeder channel and farm ponds is maintained above the average low water level during neap tides which helps in filling the ponds in both spring and neap tides and evacuating the ponds in low tides. The feeder channel is trapezoidal in shape and its bed is maintained approximately 30 cm below the pond bottom. The major loss of head in case of open channel is due to friction between water and the sides of the passage to which the water touches. Hence a balance should always be maintained between the frictional loss and drop in elevation of the channel bed to maintain a uniform flow in the channel.

Perimeter dyke

The entire farm land is protected by stable earthen dyke on all sides

The height of dyke affects the design of dyke to a large extent. Hence much care has to be taken in deciding the safe height of dyke in order to make the dyke perfectly stable. The height is fixed taking into consideration the maximum tidal rise, clearance for wave action, allowance for settlement of dyke and clearance for free board to prevent the dyke from overtopping. A clear height of 1 m as free board is found safe for tidal dykes.

The dyke is predominantly constructed of soils available from pond excavation. The excavated earth is laid in layers in the profile of dyke watertight. The dyke resting on poor sub-base or built on narrow drainage outfall should be adequately strengthened by driving wooden piles in the base and edges of the dyke to prevent subsidence and slipping of the dyke.

As the side slopes of dyke is a function of the nature of soil used in building the dyke, it is found that for a dyke of 3 m height, side slopes of $2\frac{1}{2}$: 1 on the river side and 2 : 1 on the farm side make the dyke perfectly stable. The river side face of the dyke is provided with bricklining in cement morter to prevent seepage, check soil loss due to erosion, to maintain the hydraulic gradient well within the dyke and also to check the burrowing animals from making holes and tunnels. In order to render the foundation of the dyke impervious to seepage water sometimes out off in the form of masonary wall or clay puddle is made in the bed under the dyke upto a depth of 2 m to prevent water from percolating underneath the dyke. Similarly puddle core with clay soil is provided in the centre of the dyke to make the dyke perfectly watertight. The crest width of perimeter dyke is usually kept 2 m or more to facilitate easy movement of material, manure, farm equipments etc.

Secondary dyke

The secondry dyke are constructed for the purpose of dividing the farm into several ponds, and the dykes prevent the pond from overflowing. The height of secondary dykes is decided taking into consideration the maximum water level in the pond, allowance for dykes settlement and margin for free board. The dykes are built sufficiently strong against lateral thrusts due to waterhead and drawdown in the pond.

Main and secondary sluices

The prawn farms have mainly two types of sluices -

(i) Main sluice and (ii) secondary sluices.

Main sluice

The main sluice takes care of water supply for the whole farm ponds and it is generally constructed at a place in the perimeter dyke which is not subjected to direct impacts from tidal waves. The sluice serves the purpose of controlling the inflow during the flood tides and outflow during the low tides. The main sluice usually consist of conventional draw shutter iron gate with radial wheel and gear rod lifting device, masonary abutments, wing walls, pucca apron with cut offs etc. The vent

area of the sluice is kept sufficiently large to fill all the ponds to their optimum depth during the tidal phase. The sill level of the sluice is kept at feeder channel bed to maintain non-turbulent flow in the channel.

The main siuice can be made more effective by bringing suitable changes in the design of the sluice structure. In place of a single vent, two tier double vent hume pipe structure with two sluice regulatory gates installed at different levels can help in taking well oxygenated silt free surface water to the farm through the top level sluice while dewatering can be done by opening the bottom level sluice during the ebb tide period. Both the sluice can be located in a single monolithic structure for easy operation of the tidal flow. The projecting dissipators on the pucca apron reduces the dynamic energy of the tidal flow and protects the sluice from bed scouring.

Secondary sluices

Prawn ponds receive the supply of tide water through the secondary sluices which are fitted on the main feeder channel in the farm. The secondary stuice control the water flow in the pond and it is located in such a way that plug flow is maintained in the pond. The sluice is built of sal wood and is much simpler in design. The sluice is basically a closed box type wooden structure, four sides are covered by wooden planks and wooden lift shutters at both ends act as water control devices. The shutters freely ply in the slightly inclined grooves which are left in the adjoining wooden frames of the sluice box to make the sluice leak-proof. The sill level of the sluice is kept at pond bed for proper water replenishment in the pond. Screen gates are also used to prevent the entry of predators while allowing free flow of water into the pond. The gate is operated when the tide water reaches about 30 cm above the sill of sluice to prevent eddies and whirlpools to occur in the pond which will otherwise scour the pond the bed and firghten tho young shrimps from entering into the pond. The dyke adjoining the sluice ends is checked from slipping by fixing wooden planks on vertical logs deeply embedded in the ground.

Construction of pond

The site is first cleared of all mangrove forests, vegetation, roots etc. by excavating and removing the top soil for a depth of 30 cm. Big size tree stumps which are virtually difficult to cut and remove manually from the pond bed are burnt to ashes and the pond surface is levelled.

The lean months are normally chosen for construction of pond to minimise the cost of construction. The tide table gives guidance for the time to be chosen for construction. The working hours are so arranged as to take maximum advantage at the low tide period.

For minimising the cost of construction, the prawn ponds in Sunderban regions are commonly built by removing the top soil hardly exceeding 45 cm and the surface is cleared of vegetation, shrubs and mangrove roots to make the pond bed even. But the roots under-

lying the sub-base in course of time perish and decay and make the pond water toxic and unsuitable for prawn growing. This aspect should receive due consideration while planning and constructing the prawn ponds. Similarly, much care has to be taken in selecting the soil materials for building pond dykes. The soil used shoiuld be completely free from tree roots, decaying matters and large clods.

Farm Managerment

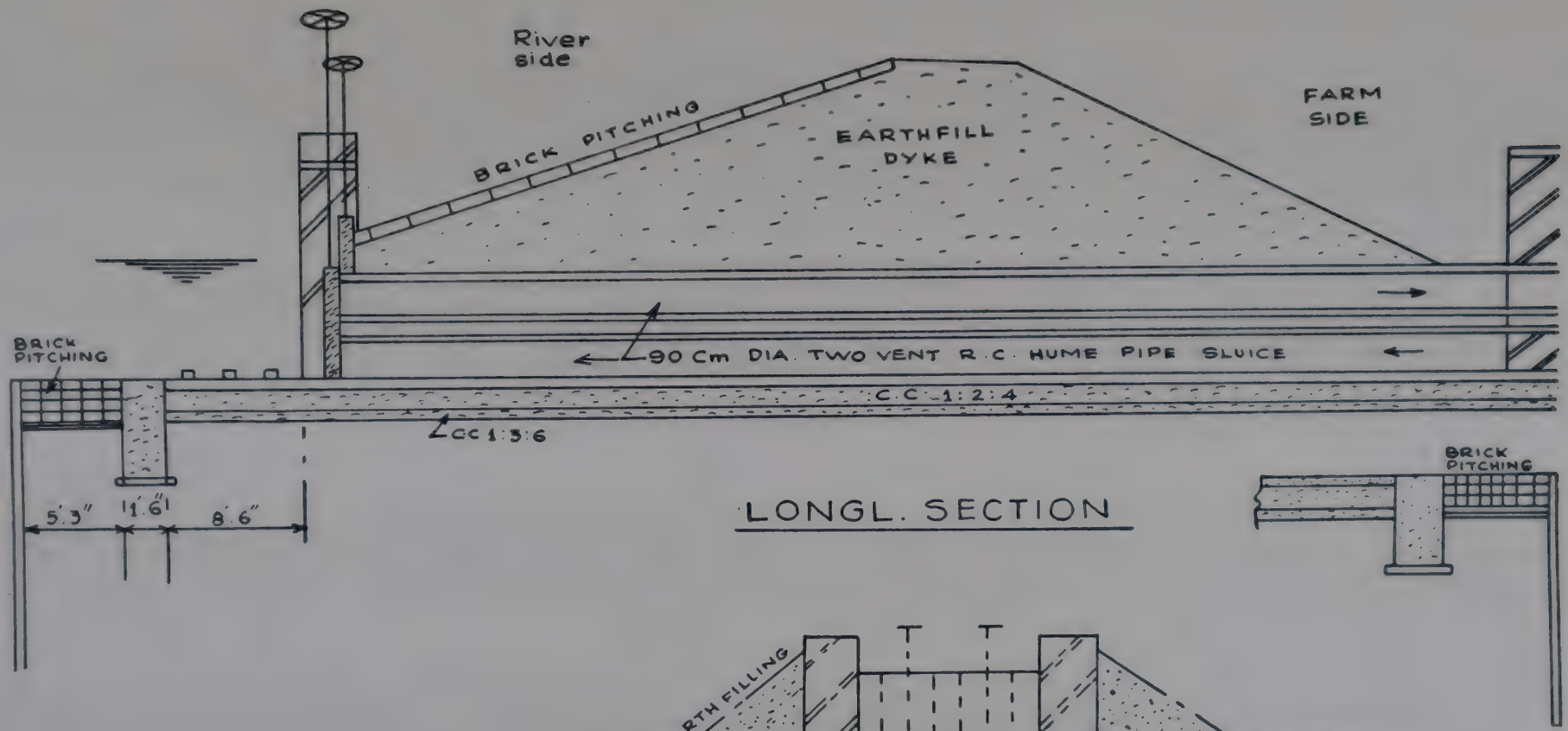
Periodical maintenance work is essential to keep the farm ponds and dykes in perfectly stable and working condition. Desiltation of the ponds is done during lean months usually in winter when the tidal amplitude is less. Silt removed from the pond is first stacked in one corner of the pond for drying and release of excess moisture from the soil. The soil is next utilised in repairing the damaged pond dykes which is done by depositing the soil in layers as per the profile of the dyke. Each layer of soil deposited is perfectly rammed and consolidated. The windward face of the dyke can be protected by planting trees in rows. A wide berm left between the dyke and the edge of the pond with slight inclination towards the dyke can check the run-off and entry of dyke washings into the pond. Half split bamboo or any other hard wood poles driven very closely at the tocline of dyke can appraciably strengthen the dyke.

The perimeter dyke can be strengthened by stocking heaps of brushwoods on the outer slope of dyke which minimises the tidal impacts and attract silt to deposit. Permeable silt cage or hanging spurs can be effectively utilised to strengthen the dyke particularly built across a tidal creak or drainage canal. The silt to settle in the cage and thus forms a counterberm of the main dyke to strengthen it.

One of the major problems in farm maintenance is mud lobster *(Thalassina anomala)* which burrows in dykes, cause leakage and make the dyke unsafe. This menace can be counteracted by applying quicklime in burrow.

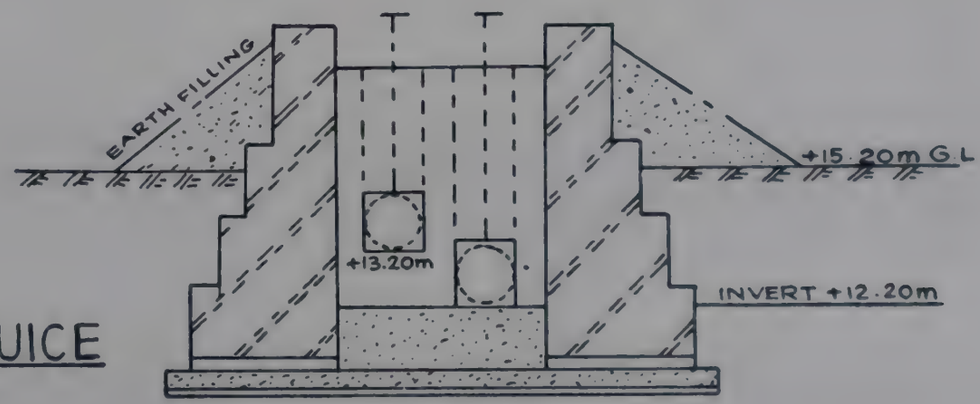
Balanus colonies which adhere to the wooden sluice gate interfere with proper operation of sluice. Regular scrapping the wooden surface or masonory structure and their painting with antifouling paints or coal tarring prevent the growth of fouling organisms.

Luxuriant growth of filamentous algae often cause large mortality in prawn ponds owing to increase in oxygen content sometimes to supersaturation level during daytime and abrupt depletion during night. This problem can be overcome by proper pond aeration and maintaining the pond gradient atleast 1 : 2000 in alluvial soil, for proper flushing.



LONGL. SECTION

DESIGN OF TWO VENT SLUICE



CROSS SECTION

PRAWN FARMING SCHEME OF 7TH FIVE YEAR PLAN OF THE MINISTRY OF AGRICULTURE

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1. Description of the scheme on the development of brackishwater fish farming

During the VIth Five Year Plan (1980-85) a new Centrally Sponsored Scheme on brackishwater fish farming with area development concept was introduced with a capital outlay of Rs. 996-00 lakhs to be shared between the Govt. of India and the State Govt. on 50 : 50 basis. Initially, eight maritime states and three inland states namely, Punjab, Haryana and Rajasthan were considered under the scheme for development of 1500 ha benefitting about 1000 fish farmer families. Subsequently, in September 1983, the scope of the scheme was extended to the Union Territories of Goa, Pondicherry Laccadives and Andaman & Nicobar Islands. In 1982-83, the ministry of Agriculture released a sum of Rs. 43 lakhs on ad-hoc basis ranging from 1 lakhs to Rs. 7 lakhs per state for meeting the initial cost on preparing project reports. In the subsequent years of the VIth plan, adequate budgetary support was made for the scheme in anticipation of receiving a large number of proposals from the State Govts. and the Union territories, but the response was unsatisfactory. The project would have the common facilities such as supply channel, feeder channel, Bundh, inlets and outlest, sluices etc. These works would be analogous to typical irrigation projects where the Govt. bears the expenditure on capital investment for construction of common facilities and the farmers have to pay only relatively modest amount as water supply charges. The State Govts. would identify and develop suitable brackishwater areas and settle them to the farmers on long term lease. The identified farmers would be trained on brackishwater farming practices for a period of three months. They would be given on lease basis 1 to 1½ ha of developed brackishwater farms. While selecting the beneficiary preference should be given to those who belong to weaker sections of the society with no income to sustain their family. Initially fish prawn seed would be supplied through collection from natural sources As and when more and more brackishwater areas are developed for farming

purposes, commercial prawn seed hatcheries in each maritime state would be set up to supplement the seed from the natural source. One such hatchery is being constructed under the scheme at Bada-Pokharan in Maharashtra at an estimated cost of Rs. 24 lakhs.

2. Progress so far made on the development of brackishwater fish farming :

Against the target of 1500 ha, it has been possible to approve projects covering 400 ha of brackishwater area as indicated below:

Maharashtra	... 50 ha sanctioned for Rs. 23.10 lakhs
Kerala	...140 ha for Rs. 72 lakhs
Andhra Pradesh	.. 50 ha for Rs. 25 lakhs
Tamil Nadu	... 50 ha for Rs. 25 lakhs
West Bengal	... 80 ha for Rs. 40 lakhs
Orissa	... 16 ha for Rs. 8 lakhs
Haryana	... 10 ha for Rs. 6 lakhs

A project for developing 460 ha in Chilka area at a cost of Rs. 220 lakhs is being sanctioned.

3. Target for the VII plan

During the VII Plan period, it is proposed to develop 10,000 ha of brackishwater area at an estimated cost of Rs. 30 crores. According to the pattern of assistance 50% of this amount is to be met by the State Govts. It is proposed to give special attention to the paddy cum fish and prawn culture in Kerala, Karnataka, West Bengal as well as in some other potential States. A special engineering cell is proposed to be established in maritime states for preparing bankable projects. To support the scheme, the CICEF project will be strengthened with FAO/UNDP assistance.

4. Constraints in implementing the scheme:

a) The scheme for the development of brackishwater fish farming was approved by the Govt. of India in September 1982 with specific financial limits for each component in the fish farm with an upper limit of Rs. 49,000 per ha. Most of the proposals received from the State Govts. exceeded this limit and therefore it could not be sanctioned under the present conditions stipulated.

b) Although the CICEF Project, Bangalore has acquired high tachnical skill in the designing of fish farms, it does not have the support of a Fishery Scientist/ Aquaculturist to advice the engineers on the biological aspects of the project.

c) The State Govts/UTs also do not have the requisite trained personnel to identify suitable sites and prepare on their own project reports on fish farms.

5. Steps proposed to be taken to remove the constraints and expedite progress:

a) A UNDP assisted project consisting of experts on coastal aquaculture,

equipments etc. for a period of 3 years will be inducted into the CICEF project Bangalore. The objectives of the project are:

i) Prepare suitabile engineering designs for coastal aquaculture farm and operational procedure for the type of sites for coastal acquaculture commonly found.

ii) Test the suitability of the designs and the operational procedures including their economic efficiencies through representatives of pilot projects in selected areas.

iii) Establish on the basis of pilot project results, guidelines for design and operation of small and large coastal farms in different types of sites.

iv) Design appropriate shrimp hatcheries and assist in their establishment and operation including training of personal.

v) Train an adequate number of personal to undertake feasibility studies, including site survey, preparation of farm design and relevant cost estimates.

b) The approved ceiling cost of construction viz. Rs, 49,000 per ha is proposed to be revised in the VII plan to Rs. 70,000 per ha. It is also proposed to seek approval of the Planning Commission to restore 100% grant to the scheme instead of the Sixth plan patten of sharing the cost between Centre and State Govts.

c) In addition to the efforts of CICEF Project, Banglore and the State Govts., the MPEDA have also taken up the work of developing the brackishwater fish and prawn farming so as to identify and prepare estimates on a large number cf potential sites leading to the VIIth plan target of 10,000 ha.

d) The State Govts. Fisheries Department will be strengthened with adequate staff for looking after the work of brackishwater fish culture for which a new Centrally Sponsored Scheme has been proposed for consideration of the Planning Commission in the VIIth plan.

PROPOSED INCENTIVE SCHEMES OF THE MPEDA TO DEVELOP PRAWN FARMING IN INDIA

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The MPEDA have been running prawn farming extension service since 1979. During 6th Five Year Plan it was supposed to develop nearly 7,000 ha. and raise 3,500 tonnes of prawns for export. It could hardly achieve one-third of the orginal target due to various reasons. The major hurdles experienced so far are narrated below;

1. Fallow land of the coastal belt suitable for prawn farming is in the hands of Revenue and Forest Detpartments. The transfer of land to Fisheries Department in the State Government is not taking place. Each Department wants to preserve the right over the land and not prepared to spare for Fisheries. In some cases, where this problem does not arise, the allotment procedure is so cumbersome that it is almost impossible to get it done without delay.

2. The Government give priority to weaker sections of the society in the land allotment policy and majority of them are illiterates and financially very poor. Unfortunately, prawn farming requires literacy to understand the subject and need a lot of money on capital investment. Persons with money on capital and capabilities are not encouraged to take up prawn farming in large scale.

3. Some banks are shy to advance loan due to poor repayment by a few farmers. Prawn farming scheme is totally new to banks and many officials do not have sufficient knowledge on economics of prawn farming.

4. Regular seed supply through hatchery is yet to start.

5. Artificial feed production and availabilty of feed at retail points everywhere to farmers has not yet been developed.

6. Infrastructure development to remote places such as road

electricity, drinking water, communication etc. is neglected very badly. Like provisions for infrastructure development in agriculture, there is no provision for coastal aquaculture.

7. Technology available in the country is not sufficient to take up real scientific farming which can guarantee a production of one to two tonnes per hectare. Farmers in the traditional area is yet to be convinced on scientific farming practices. The basic infrastructure such as water supply to ponds, required to upgrade the technology, could not be made due to social problems. Since the owner of the land leave the land on short term contract for pisciculture, the contract farmers could not invest money on improvement of the land for scientific farming.

8. Though coastal aquaculture holds vast potential for prawn fish production, large scale employment and foreign exchange earnings, no adequate thought has been given by the Planning Commission. Till today, large scale planning for prawn farming is lacking. Meagre budget, allotted during plan period, does not permit a massive operation for a big country like India.

9. Government restrictions in bringing foreign experts by the private companies does not allow us to make a quick break through. Since the foreign experts demand high consultation fee, the budget of MPEDA does not permit to do that and finally we have to depend on bilateral aid programmes which again leads to delay.

10. Fishery Research Institutes which claim to have developed the technology does not want to associate with organisations like the MPEDA to put their research results into commercial practise since ICAR has restrictions to transfer the research results.

11. We have sufficient number of Fisheries Research Institutes, Financial Institutions/Banks, Fisheries Developmental agencies, District and State Administrators, Fisheries Training Institutes, Educational Institutes/Universities teaching fisheries and PWD for construction work. All these Departments/Institutions are functioning independently without any connection to each other. A developmental agency like MPEDA could not make any effective coordination since they are not given sufficient power/money.

12. Procedural administrative delay in giving subsidy or incentive to farmers does not lead us anywhere.

13. Technical manpower in thousands are required to take up prawn farming all over the country.

There is no organised full fledged training institutes or University education at Post-graduate level to teach prawn culture. Based on the past experience we have identified a few major areas to evoke interest among entrepreneurs. The major issues to tackle in front of us are:

1. Investment on development of land.
2. Assured supply of seed.
3. Supply of cheap feed to farmers at retail points.
4. Building up of technical manpower in the country
5. Application of latest technology for higher productivity.

Therefore, to develop prawn farming fast in India the MPEDA have proposed the following incentive schemes:

I. Subsidy for development of new farms

Since the development of new area is highly capital intensive ranging from Rs. 40,000 to Rs. 1,00,000 per hectare, the entrepreneurs are shy to invest on prawn farming. To break this dead lock and stimulate interest among private farmers the MPEDA have proposed a capital subsidy within the limited resources available from the Ministry of Commerce.

It is proposed to develop 2,250 ha during Seventh Plan under the direct assistance of MPEDA apart from other schemes such as DRDA, ERRP, ADP etc. which are run by the Ministry of Agriculture and State Governments. These schemes cover the interest of weaker Section whose income does not exceed Rs. 3,500 per annum. To accommodate the interest of small, medium and large farmers, the MPEDA have proposed to apply the following strategy.

1. Small farmers

Farmers, developing a water area of 5 ha or less will come under this category. It is not classified according to the income. The capital investment in the form of fixed cost may vary from Rs. 40,000 to Rs. 1,00,000 and variable cost around Rs. 10,000 per hectare for extensive farming This will go up for semi-intensive and intensive farming practices. Since we are aiming extensive farming to start with, it is proposed to give a subsidy to the tune of Rs. 20,000/- per ha upto five hectares per individual. The rest of the money required to cover up capital cost and variable cost may have to be met from bank loan. Those farmers who avail assistance in the form of subsidy from other schemes (DRDA, ERRP etc.) will not be eligible for any subsidy from MPEDA. Only one member in a family will be eligible for subsidy.

Medium farmers

Farmers, developing a water area of more than 5 ha and less than 20 ha, will fall under this category.

He will be eligible for a subsidy at the rate of Rs. 10,000 per ha, irrespective of variying cost on capital investment.

The rest of the money has to be covered under bank loan or from his own sources.

Large farmers

Farmers, developing a water area of more than 20 ha and less than 50 ha, will be classified under this category. He will be entitled for a subsidy at the rate of Rs. 4,000/- per ha upto 50 ha. The balance amount may have to be met from bank loan/own sources

Big companies, developing a water area of more than 50 ha will not be eligible for any subsidy. The capital subsidy of MPEDA will be linked to bank loan. Procedure of selection of farmers will be worked out in consultation with State Fisheries Departments. A sum of Rs. 237.47 lakhs has been proposed to spend under this scheme during the current plan period and develop 2,250 ha to produce 2,250 tonnes of prawns, worth of about Rs.22 crores.

II. Financial assistance to set up Prawn Seed Banks :

Assured supply of seed at the time of need is a "must" to develop prawn farming in a systematic manner. We have to depend on natural seed resources till sufficient number of hatcheries are set up in India. Country like Ecuador is collecting upto 10 billlon seeds every year from the natural resources and meet requirement of 40,000 ha. About 90,000 artisanal fishermen are engaged in seed collection and the seed supply to farmers has been systematically developed. We arey et to identify our natural seed resources in many estuaries and train up such a large number of people in seed collection. The MPEDA has so far given training to 1,000 fishermen/seed collectors in different parts of India which is hardly sufficient to meet our demand. Seed collection and transportation is done in a crude way at present without any basic infrastructure for collection, storage, packing and transporation. Therefore, it is proposed to encourage private entrepreneurs to set up "Seed Banks" in all major collection centres by giving financial assistance to the tune of Rs.20,000 per seed bank. The cost of one seed bank has been worked out approximately Rs. 1,35,000/- out of which capital cost on temporary shed, plastic pools, water pump, compressors etc. works out to be Rs. 1,00,000 and recurring expenditure Rs. 35,000/-. The subsidy proposed by the MPEDA will cover about 50% of the cost ot machineries and the balance may have to be met from bank loan. A few seed suppliers who are already doing this job in a crude way may be considered for further improvement. At the rate of 5 seed banks per year, it is proposed to set up 25 seed banks during the current plan period at the cost of Rs.5 lakhs.

To identify potential area for seed collection, it is proposed to conduct seed resources survey in a few estuaries which have not been covered so far. It has also been proposed to introduce seed transportation vans in a few State during the current plan period.

III. Financial assistance to set up prawn hatcheries :

Prawn hatcheries for large scale seed production are not coming up in

India despite several schemes in the Fisheries Departments of Maritime States under the support of Ministry of Aquaculture. It would be difficult for a Government sector to run a hatchery successfully. In a country like Taiwan, 1,200 hatcheries are functroning as small family business. Therefore, it is proposed to encourage private entrepreneurs to set up hatcheries. To set up one hatchery in the capacity of 6 million post larvae per year, it costs approximately Rs.12 lakes ie. Rs. 10 lakhs on fixed cost and Rs. 2 lakhs on variable cost. It is proposed to give 50% subsidy on fixed cost ie. upto Rs. 5 lakhs per hatchery and the rest ie. Rs. 7 lakhs may have to be met from bank loan. It has been proposed to set up four hatcheries for penaeid prawn and two hatcheries for giant freshwater prawn (macrobrachium spp.) during the current plan period. A total of Rs. 30 lakhs has been proposed for fhe subsidy.

In addition to this we have proposed to set up three large penaeid prawn hacteries (each with 25 million post larvae) in the east coast through bilateral aid from Japan, USA and France. Each hatchery involves an outlay of Rs. 50 lakhs in Indian currency and US dollar 2.0 lakhs in foreign currency for consultancy charges. It has been proposed to extent financial assistance to the State Fisheries Departments/Cooperative sector to the tune of Rs. 30 lakhs for one hatchery and the rest may have to be met by the concerned State Government. Rs. 90 lakhs has been proposed for three hatcheries during the current plan period.

IV Subsidy for the supply of prawn feed

Prawn feed is a vital component among inputs and the supply of proper feed to farmers is a "must" to increase the yield rate which is very low at present (less than 500 kg/ha/year). The success of Taiwanese to achieve an average yield of 5 tonnes ha/year through semi-intensive farming is attributed for the successful development of prawn feed. No proper feed has been developed and produced so far in commercial scale in India. M/s. TOMCO Madras has made first attempt to produce 100 tonnes of feed for trial feeding at the cost of Rs. 4,500/- per tonne. The success of this feed formula is going to be tested in a few Centres shortly. Since feed formula is kept secret, many countries are still importing feed from Taiwan and it is reported that the Taiwanese feed is giving better result for tiger prawns in terms of yield rate and cost which is about one US dollar per kg. Since import of feed attracts 100% duty in India, it works out nearly Rs. 25 per kg which is found to be uneconomical. Therefore, a few foreign companies have been approached to set up feed mills in India through joint venture.

It has been proposed to give upto 75% subsidy on cost of feed for small farmers who are having an area of 2 ha or less and for others upto 50% subsidy. An amount of Rs 60 lakhs has been proposed to spend during the current plan period on subsidy of feed. The objective of this scheme is to induce the farmers to use feed for raising the current yield rate per hectare.

Building up of technical manpower :

Acute shortage of technical manpower in different disciplines of coastal aquaculture has been felt in India. The courses run by CMFRI and other Fishery Institutes could not produce even 100 students per year. In a country like Taiwan, special course on aquaculture is run for 3 years and we are yet to develop such course with curriculum on latest technology in India. Therefore, it has been proposed to start a special course on aquaculture in all Maritime State Universities of India. A token provision of Rs. 5 lakhs has been proposed and it will be revised, if necessary, after seeing the response. A few Universities, have already evinced interest to start such course on course on aquaculture.

in addition to this, the MPEDA have proposed to sponsor a few teams of technical experts and enterprising farmers to South East Asia to study the latest technology in coastal aquaculture and apply the same in India. It is also proposed to bring out Aquaculture tit-bits on current developments, farmers' Hand Book, Film on prawn culture and other extension literature from time to time.

GENERAL INSURANCE CORPORATION OF INDIA BRACKISHWATER PRAWN INSURANCE

T S RAMAKRISHNAN

General Insurance Corporation of Indid, Bombay

INDIA is the 7th largest nation in the world and the 2nd most populous country. Nearly 60% of the population live in around 6 lakhs villages and contribute to nearly 80% of the country's agro-based economy. The emphasis on agricultural and rural development in the successive Five Year Plans aimed at growth for social justice, achievement of full employment in rural areas and ultimate removel of proverty. Also the agricultural base having become strong and more diversified, creating of surpluses and promoting export in respect of some commodities which have high growth potential is a natural corollary. In the process, special attention is being paid to backward areas as well as to the scheduled casts, Scheduled trlbes and other weaker sections of society who are among the most disadvantaged sections of the population. Empyasis is laid on accelerating development in these areas by overcoming the weakness in infrastructure and socio-economic system which keep down their growth.

Diversification of production base through the process of mixed farming (cropfish - livestock integrated production system) as a means of increasing invetsment, employment and income per unit of land and integrating crop production, fisheries, animal husbandry, etc., has been found to be particulary relevant for developing the economy of the small and marginal farmers.

Agricultura and rural development is essentially a state subject and success depends on the efforts made by the state Goverments.

Fisheries

Fisheries and fishermen are an integral part in the history of Bharata Varsha that is our country. Lord Vishnu, the puranas say, took the form of a fish to retrieve the lost Vedas. Sage Veda Vysa, the author of the Epic,' Mahabharatha' is said to be the son of Satyavathi, a fisherwomen. No wonder, nature has also blessed our country with bountiful rivers and a coastal line of 6,536 kms. Continental shelf accounts for 452,000 sq. kms.; reservoirs-20,000 sq. kms ; river systems and canals dotted with lakes, dams, estuaries-80,000 kms; tanks and ponds - 15,000 sq. kms.; lagoons and backwaters - 12,000 sq. kms. and backishwater area of about 14,000 sq. kms.

The total no. of fishermen in our country is estimated to be 50 million, of which about ten million live in over 1,800 villages in coastal areas.

Fisheries, thus, offer immense scope to fulfil the basic objective of production-cum - full employment. This is also one of the sectors eminently suited to assist a large mass of economically weaker backward sections of the rural community.

Statistics show that export of marine products in 1983-84 stood at 92,691 tonnes earning valuable foreign exchange.

Natuarally the emphasis is to step up considerably the annual fish production-both in marine and inland sectors and to organise inland fisheries production based on individual family basis and on high labour intensive, low investment technologies, etc.

It is also the declared policy of the Government to expand brackishwater fish farming which has been identified as a potential source of augementing the income of individual fisherman families and thus to increase production of prawns for export, besides home consumption.

In marine fisheries, the traditional coastal fisheries sector is estimated to engage nearly one lakh country crafts operated by small fishermen. Insurance for these on a group basis will be available.

General insurance

In india till nationalisation in 1973, the General Insurance Companies functioned purely on commercial lines catering almost exclusively to the needs of trade, commerce and industry and that too in respect of traditional insurance covers like fire, motor goods in transit, etc.

After nationalisation, the General Insurance industries in keeping with the declared objectives of making general insurance meaningful to the common man and to spread the message of general insurance in the rural sector, started cattle insuranse in 1974.

In 1976, the Janatha Personal Accident Insurance Cover was introduced. This policy is for a sum insured of Rs 15,000.00 and the premium is only Rs. 12/- per annum. Based on the representation made by the national Fishermen's co-operative Federation, Government of india has been pleased to grant 50% subsidy of the JPA Policy premium to all fishermen in the country who are members of fishermen's Co-operative Societies.

Pond fish insurance

In view of the massive intergated rural Development programme of developing inland fisheries and thus to enable the weaker sections of society to rise above the poverty line by providing such gainful-time, part - time occuptaions, GIC evolved a Pond Fish Insurance scheme which has been commended to the project authorities.

Brakishwater prawn insurance

In view of the policy of the Government to expand brackishwater fish farming, there have been persistant demand for prawn insurance. GIC and its subsdiary companies held series of meetings with state Fisheries department also with MPEDA.

It was pointed out that India is bestowed with about 2 m. ha. of Brackish-water area suitable for development of prawn culture.

Prawn culture is done traditionally in the bheries of West Bengal and Vypeen area of Kerala since a long time and prawn farming is being done now in parts of Orissa, Andra pradesh, Maharastra, etc., also. The Central Inland Fisheries Research Institute at Barrackpore, Central Marine Fisheries Research Institute at Cochin and Central Institute of Fisheries Education at Bombay have conducted studies / experiments which is the forerunner of the present technology.

MPEDA has thus an ambitious plan for Brakishwater prawn farming. The production in the present traditional way which is only about 15,000 tonnes in nearly 32,000 hectare whereas in Japan, Korea, etc., the production was 2 to 4 tonnes per ha. GIC has, therefore, come forward to offer insurance protection for brakishwater prawn farming also. The fish farmer would be assured of risk cover and would be encouraged to make with confidence, full investment for development of pond as well as inputs to get more production. The scheme is given in Annexuer 'A'.

Annexure 'A'

1. Implementing Agency :

The National Insurance Co. Ltd., Calcutta, New India Assurance Co. Ltd., Bambay, The Oriental Insurance Co., Ltd., New Delhi and United India Insurance Co., Ltd., Madras.

2. Objective of the Scheme :

(a) To provide insurance cover against total loss of prawn, nursed seeds in hatcheries owned by State Governments, FFDAS, State Fisheres Corporations, MPEDA or such other organisations.

(b) To provide insurance cover to those engaged in brackishwater prawn farming against total loss of seedlings/juveniles/prawns of all species raised in brackishwater after being transferred to the farms.

(c) To provide insurance cover to financial institutions to protect their interests and recover loans advanced for such brackishwater prawn farming in the event of loss.

3. Basis of Valuation :

The Scheme will cover either the input cost or fixed value of the produce.

(a) *For Hatcheries :* In case of prawn seeds/juveniles/fry of a hatchery owned State Government/State Fisheries Devt. Corporation, MPEDA etc., the cover will be only for the input cost.

(b) *For Prawn Farmers* : If the insured wants to cover the risk on input cost basis only, then the premium will be charged on the input cost only as fixed by a nominated officer of FFDA/Fisheries Deptt./ CIFRI/MPEDA issued at the time when the proposal is made for insurance. This will be treated as part of the policy and shall form the basis for claims settlement.

However, if the insured wants to cover the risk of the produce on a fixed value basis cover will be provided on the basis of the certificate issued by any of the above mentioned competent authority indicating the valuation of crop at each stage during a crop period.

While fixing the value of produce for insurance purposes at each stage applicable percentage of natural mortality shall be excluded.

Such certified valuation table giving value of produce for each stage will be obtained at the time of proposal and shall form the basis for acceptance of insurance as also for settlement of claims.

4. Period of Cover :

(a) *For Hatcheries* : From the stage prawn seeds being sowen in hatcheries for rearing till the post larve are removed from the hatcheries.

(b) *For Farms :* From the stage of transferring of post larve to the brackishwaters till actual harvesting (usually starts from 4th month or as per local practice).

5. Rate of Premium :

4% (gross) on the certified value declared for insurance for each crop period, subject to minimum premium Rs.30/- per day.

6. Scope of Cover :

The insurance covers total loss or destruction of prawns due to accident and disease -

(a) Summer kill

(b) Pollution

(c) Poisoning

(d) Riot and strike

(e) Malicious acts of third parties

(f) Earthquake

(g) Explosion/implosion

(h) Storm, tempest, cyclone, typhoon, hurricane, torando, flood, inundation, volcanic eruption and/or other convulsions of nature (flood/inundation excludes normal tides)

(i) Aircraft and other aerial devices or articles dropped therefrom, impact with any road vehicle, horses and cattle.

(j) Shell disease, vibriosis aeromanas celiades and other viral form of epidemics/and/or parasitical attacks.

Note- 1. Extension Policy :

Policy can also be extended to cover the bunds/sluice gates, etc., against natural perils as mentioned above subject to certificate of valuation and payment of extra premim@ of ½% (gross)

2. Excess :

Each and every claim shall be subject to a deduction of 20% from the claim amount payable. In other words, the Company's liability in the event of total loss will be only 80% of the assessed value.

The excess of 20% does not however apply :-

(i) when realisation of salvage is not possible.

(ii) When salvaged prawn are destroyed on the ground that they are unfit for human consumption (eg. poisoning)

7. Exclusions :

Malicious or wilful destruction of prawns in pond due to negligence error and/or omission infidelity, improper management and/or rough handling by insured or his family members and/or employees.

(ii) Losses due to natural mortality and/or under-growth/overcrowding

(iii) Production loss unless caused by any of the perlis covered by the policy.

(iv) Any destruction in compliance with requirements of any statue or any order of Government/Municipal or other Authority except where Company has expressly agreed.

(v) Losses caused by predators, competitors and/or Weed fish.

(vi) Losses due to chemical status of soil and/or physical and/or chemical status of water and PH factor unless associated with climatic change.

(vii) Theft, dacoity, looting, holding or clandesting sale or mysterious disappearance of prawns from the brackishwater.

(viii) War, invasion, act of foreign enemy, hostilities (whether war be declared or not), civil war, rebellion, revolution, insurrection, mutiny, tumult, military or usurped power or any consequences thereof or attempt thereat.

(ix) Any accident, loss destructions, damage or legal libility directly or indirectly caused by or contributed to by or arising from nuclear weapons.

8. Definition of Total Loss :

(Where the loss of prawns is so extensive due to operation of any of the insured perils that the recovery/residuel catch during a single crop period from a particular farm named in the schedule of the policy falls below 20% of the sum insured, such claims could be considered as total loss and dealt with in terms of the policy.

Such claims will be paid to the extent of 80% of the (100 - percentage of residual catch). For example, if the residual catch is 15% then the claim for total loss would become payable to the extent of 80% of 85%.

9. Claims Procedure :

Insured is required to give immediate notice by telegramme telephone and by letter within 24 hours directly

to the local policy issuing office of the company and MPEDA/financing institution in case of death of prawns which may give rise to a total loss under this policy.

Insured shall also furnish within 14 days satisfactory proof of claim along with:

1. Duly completed claim form giving reasons for the death.

2. Certificates from the FEO of FFDA or an officer of equal cadre in State Government Fisheries Department or Central Inland Fisheries Research Institute or a senior fisheries expert from MPEDA certifying the cause of death, together with the value of the stock at the time of death with details of salvage if any.

10. Underwriting

(a) The insured shall at all times exercise all reasonable care and diligence in the selection of employees and shall cause prawns insured to have sufficient and proper feeding and shall exercise every precaution and in every manner provide the same care and attention as if no insurance had been effected.

(b) It should be insured that the water level of tanks lakes ponds are maintained constantly at a level which is safe for prawn cultivation. The water movement must be regulated by suitable inlets, outlets and sluices.

(c) It is essential that the project area should have strong and sufficient bunds at all times and is supervised by adequate watch and ward staff under the supervision of a qualified technical person.

(d) The insured shall not introduce or permit to be introduced any diseased or infected fish amongst the insured stock. The insured shall also cause dead prawn or prawns attacked with disease to be completely separated from the remainder of the stock immediately upon the discovery of the attack and shall take all necessary and proper precautions to protect the healthy stock from diseased stock.

(e) Following should be ensured with regard to the prawn insured under the policy:

i. Efficient attention and/or extention service to the projects;

ii. Regular and effective liming manuring, feeding, deweeding, de-sitting, earth excavations and earth improvements at appropriate time and maintain records to that effect,

iii. Proper regulation of water movements by suitable inlets, outlets and sluices;

iv. regular water analysis;

v. follow-up of proper work schedule;

vi. proper and safe stocking;

vii. Screening or shutting the escape routes of prawns such as gaps in the embankment, etc.;

viii. immediate steps to eradicate

diseases epidemics and parasitic infestation;

ix. Proper records for maintaining daily stock position, feeding, disease occurrence and preventive measure taken, inputs and expenditure;

x. Purchase of prawn seeds from standard suppliers.

(f) The rate is dependable on mean valution of the declared value of the stock at inception at the end of the period of insurance.

(g) How to find out the mean value;

$$\frac{\text{Purchase price of Juvenilies at inception} + \text{Value of prawn at the time of harvesting}}{2}$$

11. Agency commision:

Agency commission @ 15% of the premium in respect of private business.

12. Discount:

Discount of 15 % in lieu of agency commissions where Government agencies like IRDP/SFDA/MPEDA and/or Banks are interested.

The companies may depute their official to inspect the farm if deemed necessary before acceptancc of any proposal.

BRACKISH WATER CULTURE FISHERIES PROJECT IN GUJARAT

A. Project area :

1) Potential Brackish water area available and type of ownership.

State	District	Village	Ownership Private/Govt.	Total area in hactare.
Gujarat	1. Bulsar	1. Umbergean	Govt.	50
		2. Dhelai	—	15
		3. Kelak	—	05
		4. Onjal	—	50
		5. Matwad	—	100
	2. Rajkot	1. Vavania	Govt.	200
	3. Kutch	1. Mundra	Govt.	200
		2. Tuna	Govt.	200
	4. Amreli	1. Madhwad	Govt.	200
		2. Kotada	Govt.	600
	5. Junagadh	1. Harshad/ Miyani	Govt.	25
	6. Jamnagar	1. Jediya	Govt.	200
		2. Rupen(Dwarka)	Govt.	25
		3. Balachadi	-do-	05
		4. Valsura	-do-	50
	7. Bhavnagar	1. Sultanpur	Govt.	10
				1935

2. Existing Brackish water area under different culture.

State	District	Village	Area (ha) Under			Total (ha)
			Extensive Filteration	Semi-intensive	In-tensive.	
Gujarat	1.Kutch	Mundra	—	50	--	50
	2.Bhavnagar	Sultanpur	—	10	--	10
	3.Jamnagar	Jediya	—	100	--	100
		Total	—	160	—	160

3. Is there any possibility of converting the area under extensive filteration into intensive or Semi intensive : ?

Require Detailed Study

4. What is the most suitable new area available for brackishwater culture ?

The potential areas are given in Sr. No. 1. Most suitable areas are to be decided after a detailed survey.

5. (a) Has The State undertaken any survey to identify and classify the area. ?

A preliminary survey was conducted covering 132 centres (map) and accordingly the area mentioned in Sr.No. 1 are indicated.

6. If your state are there any project existing at present ? If so, please give details.

Yes, as fellows :

	District	Village	Details
1.	Bhavnagar	Sultanpur	— A Brackish water farm of 5 Ha area. Construction being completed and farming will be started shortly.
2.	Kutch	Mundra	— A Brackish water farm of 5 Ha area under construction.
3,	Bulsar	Katwad	— A 15 Ha. Farm is under construction.

7. Please give special features of the Brackish water area in the State ?

A.	Tidal Amplitude	—	2 m.
B.	Salinity	—	30 ppt to 40 ppt.
C.	Terrain	—	Muddy/Sandy
D.	Rainfall	—	10 to 20" Saurashtra 35 to 50 S. Gujarat.

B. Leasing :

1. In the State, for leasing the area to fishermen/fish farmers, what is the normal period followed ?

TO BE DECIDED

2 What do you consider will be the ideal length of leasing period ?

15 years

3. What are the problems perceived in granting long - term lease to fishermen fish farmers in the state ?

NOT ARISEN

C. Seed availabilty :

1. Availability of prawn seed :

   Qualitative and quantitative assessment is not made. Seeds of *Metapenaeus spp.* are available in the creek of the coastal area.

2. Availabilityof fish seed for brackish water culture :

Season	Variety	Size (mm)	Source	Quantity	Method of Collection
Nov. to Feb.	Mullets	10 - 40	Natural	Large quantity	Drag net.

3. (a) Is there any hatchery, producing prawn and fish seed for brackish water culture ?

   YES, PRAWN SEED HATCHERY.

(b) Location	Hatchery area	Quantity of seed available.
Okha	0.25 H.	10 Lakh/per year Penaeus merguiensis

4. (a) Are there any plans to set up prawn hatchery in the state ?

   YES

(b) Location	Hatchery details	Total likely investment
Matwad Bulsar Dist.	ONE 0.25 Ha	2.5 Lakh initially

5. Of the total seed available, how much is now being utilised ?

Variety	Size (mm)	Quantity	Source	Cost involved
P. Merguiensis	10-12 mm	1 lakh	Farm	Rs. 4000 for hatchery.

D. Hatchery design :

1. What would be the suitable location and ideal size of future prawn hatchery in the state ?

GIVEN IN 4 (b)

2. What are the special precautions needed in setting up these hatcheries in the state ?

   1. For a continuous air supply generator should be provided.
   2. For clean sea water filteration system should be provided.

3. What would be the investment, operating cost and revenue for the indicative hatcheries ?

(a) Investment needed for :	Small	Medium	Large
1. Land (ha)	0.25	0.5	1
2. Tank (litre)	2500	5000	10000
3. Water supply Litre/day	5000	10000	20000
4. No. of 5 × 10 m Grow out ponds	2	5	10
5. Buildings size	15' X 10'	15' X 10'	20' X15'
6. No.	2	2	2

(b) Operating Cost :	Small	Medium	Large
1. Seed per 1000	Rs 40	35	30
2. Energy/month	Rs. 200	250	300
3. Feed/month	Rs. 300	400	500
4. Man power month	Rs. 10000	12000	15000
5. Supplies/month	500	700	1000
6. Misc/month	1000	1200	2000
(c) Revenue/month	Rs. 7500	10000	15000

The hatchery can become self sustaining if needed but for initial period the seed supply will have to be on attraction basis and thus the hatchery will have to be supported by Govt.

E. **Pond Design**

1. What would be the ideal size of a pond for future brackish water culture in the State ?

1 Hactare size

2. What would be a suitable desgin in the State for such ponds?

Being designed

3. What would be the invstement needed to construct such ponds?

Size (ha.)	Likely investment (Rs.)
1 H. farm	Rs. 50,000

4. What would be the public infrastructure needs and the investments needed thereof?

Needs Detailed Study.

5. What would be the investment needed to improve the existing ponds?

1. Sultanpur farms Bhavangar - 5 H. farm	Seepage	Depend on local condition.

F. Production :

1. Not yet started.

G. Infrastructure :

1. What is the requirement of ice plant, cold storage, and processing plants for existing production in your State?

Available in each coastal District near the fish landing centres.

2. What is the available capacity of ice plant/cold storage/processing plants.

1. Ice facteries (In Gujarat)	174 Nos.	1853 tonnes/day
2. Cold storage (In Gujarat)	36 Nos.	30255
3. Freezing plants	15	1585 tonnes/day
4. Frozen storages	15	2880

H. Funding Arrangements:

1. As suggested,

2. What would be the rate of interest chargable for such loan and what should be the terms and conditions for landing such loans (say maturity period and grace period, security, etc.) ?

Monatorium paid for first 3 year later on interest @ not exceeding 9%. Subsidy on NCDC basis. Security to be decided.

I. Organisation:

1. Please give the organisation chart of your Fisheries department upto the district level.

Commissioner of Fisheries - Head of Dept.
Dy. Commissioner of Fisheries - Regional Heads
Asstt. Director/Research Officer - Divisional Heads
Supdt. of Fisheries/Asstt Research Officer-Programme I/C. District level
Sr. Research Asstt./Survey Asst./Fisheries Officer
Fisheries Asstt. - Operating Officer (Field Officer)

2. What kind of organisation would you suggest suited for ?

(a) Undertaking the project

1. Fieldman/Lab. Asstt - 2
2. Sr. Research Asstt. - 2
3. Asst. Research Officer - 1
4. Research Officer - 1

(b) Monitoring the project:
Chief Research Officer.

(c) Coordinating the project :
Dy. Commissioner of Fisheries - Research

Can you also indicate the manpower requirements and likely cost for such Organizations ?

11 Persons 2.5 lakh/hatchery,

3. What should be the role of MPEDA in the brackish water culture Fisheries project.?

1. Site selection
2. Type designs
3. Technical assistance in the operation of the project.

4. What could be the role of Corporations in the brackish water culture fisheries project under preparation ?

1. Operation of culture farm.
2. Marketing of production.

5. What would be the role of FFDAS in the brackish water culture fisheries project under preparation ?

Operation of Farm

6. What could be the role of Central Institute of Coastal Engineering for Fishery in the above project ?

    1. Selection of site.
    2. Designs of farm.

J. Training and Manpower :

1. What are the type of training given at varies levels and institutions involved in your State ?

    1. Fisheries Training Centre
    2. Inservice Training to the first appointed technical staff.

2. What kind of training of manpower would be required for implimenting the proposed project ?

    1. Shrimp hatchery specialists
    2. Aquaculturist
    3. Fish farm management.

3. What would be the cost of training ?

    Rs. 1 lakh for the entire unit for one year.

4. What is the availability of manpower and what kind of additional manpower would be required for coordinating and implementing the proposed project ?

    At present only skeltal manpower for basic applied research for undertaking a state vide programme a full fledged staff compart as mentioned in Sr. No.2 will be required.

5. For the new project, what would be the cost of total manpower requirement ?

    2.5 lakhs per unit 4 contigencies, vehicles and infrastructure.

K. Consulting services :

1. Do you think the project may need the help of Experts' Consultants in any of the following for implementation and coordination of the project ?

1. Aquaculturists	YES
2. Fish Farm Engineers	YES
3. Training / Extension specialists	YES
4. Shrimp Hatchery specialists	YES
5. Institutional Experts	YES

L. Environmental Impacts :

1. Will the project have any impact on the ecological balance ?

The project will be selected taking in view that the local ecology is not disturbed.

2. Will it have any impact on the cropping pattern of other agricultural crops.

No

3. Will the environment have any impact on the project (e. g. polluted water like sewage waters) ?

Certain potential areas for developing Brackish water farming have not recommended due to the polluted nature of water likely to spread in the area during monsoon in the South Gujarat. Only after taking enough precaution for the treatment of the effluent discharges such areas can be considered. The areas suggested are far from pollution at present. The hazard could be lesser in the Sourashtra-Kutch, sites.

M. Cast and Return of Typical Brackish Water Prawn Farms :

1. Please indicate the details of cost and return of a typical prawn pond model of 10 hactare in your State.

10 Hactare.

a. Investment in excavation and pond improvement : 5 Lakhs.

b. Operational Cost :

Seed	50,000
Fertilizer	25,000
Supplementary feed	10,000
Pesticide	5,000
Labour cost	15,000
Broker's commission	5,000
Fuel/Electricity	2,500
Repair/Maintanance	5,000
Miscellaneous	5,000
Annual Incremental Operational cost.	2,5 00

C. Revenue :

Number Crop/year	2 crops
Stocking rate	1 Lakh/ha. (PL-10)
Survival rate	50%
Average weight	15 - 20 gms.
Annual incremental Revenue	25,000/ha.

Production.	1 ton/ha.
Price of shrimp/kg.	Rs. 25/-
Annual incremental revenue.	25000/ha.

Items for Prawn Hatchery

Sr. No.	Item	Size/Capacity	Requirement	Total approx. price.
				Rs. Ps.
1.	Plastic portable pools	2' dia × 3'	6	5850-00
2.	-do-	3' dia × 2'	10	12000-00
3.	-do-	6' dia × 3'	4	6000-00
4.	-do-	12' dia	3	7500-00
5.	Fiberglass reinforced tank.	1000 litres	2	9800-00
6.	-do-	670 ,,	2	10600-00
7.	-do-	300 ,,	2	5000-00
8.	PVC tubings	$\frac{1}{3}$''	-	500-00
9.	-do-	$\frac{3}{4}$''	-	200-00
10.	-do-	2''	-	1100-00
11.	Regulater T-etc.	-	-	200-00
12.	Air diffusser stone white porous	-	12 dozen	325-00
13.	Instent air pump PVC for transporting breeder from vessel.	-	-	140-00
14.	Aerator with complete accesseries.	-	12 Nos.	700-00
15.	Nylobolt 15 ND 18 ND 20 ND 25 ND	Each 5 mtrs.	-	2000-00
16.	Microscope (Binacular)	-	2 Nos.	8000-00
17.	Diseceting Microscope	-	2 Nos.	500-00
18.	Aquarium with stand 36'' × 15'' × 15''	-	6 Nos.	8000-00
19.	Diesel operatar air compresser.	1.5 HP	1	7000-00

20.	Electrically operated Air compresser.	3 HP	1	11000-00
21.	Electric water heater	1500 w.	1	500-00
22.	Refrigerater (286 ltrs)	-	1	6200-00
23.	Dissection Box	-	1	100-00
24.	Plastic drums	70-90 ltrs.	6 Nos.	600-00
25.	Glassware & Chemicals	-	-	5000-00
26.	Misc.	-	-	2000-00
			Total.	110815-00

KUTCH DISTT.

1. Khavda
2. Banni
3. Lakhpat
4. Kori creek
5. Koteswar
6. Narayan Sarovar
7. Jakhau
8. Mandvi
9. *Mundra*
10. Bhadresar
11. Tuna
12. Kandla
13. Surbrari

RAJKOT DISTT.

14. Kajerda
15. Hanjiasar
16. Lakhiasar
17. Jajasar
18. *Vavania*
19. Varshamadi
20. Navlakhi

JAMNAGAR DISTT.

21. Jodia
22. Balachadi
23. Sachana
24. *Valsura*
25. Rozi
26. Bedi
27. Sikka
28. Salaya
29. Kathumba Area
30. Kiu bay Area
31. Okha
32. Mithapur
33. Shivrajpur
34. Varvala
35. *Rupen*
36. Dwarka (Gonticreek)
37. Okhamadhi

JUNAGADH DISTT.

38. Harsad/Miyani
39. Visawara
40. Porbunder.
41. Gossabara
42. Navibunder
43. Madhavpur
44. Shill
45. Mangrol
46. Khambhalia
47. Meghal Creek/Chorwad
48. Veraval
49. Sutrapada
50. Vadodra Jhala
51. Kob-Tab-Olvan area
52. Dhamlege
53. Nava bunder
54. Simar
55. Pajapara

AMRELI DISTT.

56. Mul Dwarka
57. Chhara
58. Sarakhdi
59. *Madhwada*
60. *Kotda*
61. Dharabunder
62. Vadhera
63. Jafrabad
64. Mityala
65. Babarkot-Varahpur
66. Pipavavbunder
67. Datardi
68. Patva

BHAVNAGAR DISTT.

69. Muhva port
70. Katpar
71. Naip/Naiyu
72. Jhanjhmer
73. Gopnath
74. Khandera
75. Sartanpur
76. Padri
77. Kakhanka
78. Hathad
79. Navaratanpar
80. Chogha
81. Bhavnagar port

AHMEDABAD DISTT.

82. Magarwadi Bunder
83. Vithal Bunder

KHEDA DISTT.

84. Khambhat
85. Dhuvaran

BARODA DISTT.

86. Dabaka

BHARUCH DISTT.

87. Sarod
88. Kavi
89. Devla
90. Islampur
91. Tankaria
92. Gandhar.
93. Dahej
94. Luvara
95. Lakhigam
96. Mehgam
97. Hansot
98. Kantiyajal

SURAT DISTT.

99. *Paradi Zankri*
100. Bhagava
101. Mora
102. Hajira
103. Magdalla
104. Dumas
105. Sultanabad
106. Bhimpor

VALSAD DISTT.

107. Danti
108. Ubharat
109. Vanshi Borshi
110. Jalalpor
111. Karady-Matwad
112. Masa Movasa
113. Mendhar
114. Dandi

115. Onjal
116. Bhat
117. *Dholai*
118. Bhadeli
119. Titlial
120. Paradhi Falia
121. Magod dungari
122. Umersady
123. *Kolak*
124. Kalay
125. Maroli
126. Fansa
127. Khatalwala
128. Talgam
129. Nargol
130. Palgam
131. *Umbergoan*
132. Daheri

AREA SURVEYED FOR BRACKISH WATER COASTAL CULTURE IN GUJARAT STATE

PRESENT STATUS OF PRAWN FARMING IN MAHARASHTRA

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Penaeid prawn spawn in the sea and the postlarvae enter the estuaries and back waters in large number for feed and growth. The age old tradition of brackish water culture has its genesis in this behaviour of prawn larvae. In Kerala, prawns and fishes are trapped for growth in pokkali fields. In West Bengal, similar practice is followed for growing prawns and fish in Bhasabada fisheries. The present concept of brackish water culture is but a prawn husbandry done systematically with fastgrowing varieties of penaeid young prawns giving them artificial feed, creating conducive envoirnmental parameters and frequent change of tidal water.

Maharashtra, with its long coastline of 720 kms and 70 creeks provide large areas for undertaking brackish water farming. In the preliminary survey, it has been found that 14,445 ha. area is suitable for brackish water culture.

The details of the area surveyed are shown below:- (*)

Sl. No	Name of the district	No. of creeks	Suitable areas in ha.	No. of important creeks	No. of the areas more than 50 ha.
(1)	(2)	(3)	(4)	(5)	(6)
1.	Thane	18	5,490	3	20
2.	Bombay	5	2,360	1	13
3.	Raigad	15	3,655	2	17
4.	Ratnagiri	18	1,682	—	2
5.	Sindhudurg	14	1,268	—	—
	Total	70	14,455	6	52

(*) Source: Department of Fisheries, Maharashtra State, Bombay

Some of these areas were considered for reclamation for paddy culture Use of kharlands for agriculture however, has certain limitions. It is expected that these lands can be better utilised for prawn culture.

In India, the cultivable brackish water area is estimated to be about 2.02 million ha. However, the estimated production from this wild culture is placed 4000 tons only, as compared to the world production of 15,663 tons (Verghese 1978) .

Maharashtra coast is one of the richest among the maritime states in the country, so far as prawn landing is concerned. The penaeid prawn landings of Maharashtra for 1981-82 are placed at 33,914 tons as against the all India total prawn production of 1,10,979 tons This is 31% of the countries prawn production. This production obviously is from capture fishery. However, recent observation show that prawn catches along the west coast have stablized (Swaminathan, 1978). It is therefore, imperative to explore new avenues for enhancing prawn production, which has great export market potential.

The main species that constitute the prawn production from capture fishery in Maharashtra are -

1. *Penaeus indicus* (Bombay and Ratnagiri Region)
2. *Penaeus merguiensis* (Bombay and Ratnagiri Region)
3. *Penaeus mondoon* (Bombay Region)
4. *Metapenaeus monoceros* (Bombay and Ratnagiri Region)
5. *Metapenaeus affinis* (Bombay and Ratnagiri Region)
6. *Parapenaeopsis stylifera* (Bombay and Ratnagiri Region)

Traditional aquaculture is not of any significance from the coast of Maharashtra, however, during monsoon it is practised in the salt pan reservoirs in Thane district. The information of the Department revealed that 46 salt pans having 1814 ha. area are used for trapping prawns and fish, giving an estimated yield of 137 tons of prawns and fish.

This practice is confined to Thane and Raigad districts only, where there are salt pans.

The Department of fisheries while considering the potential for aquaculture and the criteria for brackishwater farming programme took up studies with regard to following points-

1. Availability of economical varieties of prawn seed from nature.
2. Suitable tidal range at site.
3. Location of the site in relation to the tidal amplitude.
4. Suitability of the soil
5. Availability of fresh water source

It is seen that conditions stated above are available in the state. Main constraint, however, is the availability of quality prawn seed. Natural seed is

available in some of the states but transport of seed is yet another problem (Mammen 1975).

With the assistance of Government of India, a Pilot Project of prawn farming was estabiiseed at Ratnagiri at a total cost of Rs. 31.40 lakhs. The farm is having a waterspread area of 5.85 ha. This farm started functioning in November 1983. The observations of prawn farming at this centres are encouraging.

Under the Government of India, Centrally Sponsored Scheme, the Department has also taken up establishment of prawn hatchery and a farm at Asangaon in Thane district with total cost of Rs.64.63 lakhs. The hatchery is expected to produce annually 20 million prawn larvae. It is proposed also to establish two more 50 ha. brackish water farms, one in Raigad district and another in Ratnagiri district. With the seed produced at the hatcheries in Thane, it is expected to develop 200 ha. of brackish water area for aquaculture. However, some more hatcheries are required to be established if brackish water farming in the state is to develop extensively. It is, therefore, proposed to establish some more hatcheries, one of which will be near proposed brackish water farm at Ansure. For the VIIth Plan an outlay of Rs. 1.15 crores has been proposed under Brackish Water Farming.

With the development of prawn farming in Maharashtra, it would be necessary to train the supervisory stafft Prawn farmers will also have to be trained in the aspect of modern prawn farming technology. Institutions like Marine Products Export Development Authority, Cochin, Central Institute of Fisheries Education, Bombay and Central Marine Fisheries Research Institute, Cochin are the premier institutes, extending training to the entrepreneurs and State Fisheries Officers. There is certainly a need to expand the scope of this activity.

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STATUS OF BRACKISHWATER FISH FARMING IN KARNATAKA

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Introduction:

Prawn production through capture fisheries is declining at an alraming rate over the last 4-5 year causing great concern to the Seafood export industry and it has necessiated to look forward to the only immediate alternative method of augmentation of prawn production through culture fisheries. In our country, the potential for brackishwater fish culture is computed at 2.0 million hectares against which only 30,000 ha. are under some sort of fish culture employing traditional methods, A significant proportion of the total potential, say three lakh ha. can be readily ultilised for prawn culture. There is thus great scope for brackishwater prawn culture in India in view of the constantly increasing demand for shrimps in the export market and saturated natural fisheries.

Karnataka's scenario, as far as prawn production is concerning is not at all different from the rest of the country. The prawn production from natural fisheries is almost stagnant in the last 4-5 years and the foreign exchange earnings are fluctuating between Rs.11.00 to Rs.15.00 crores. Presently, the extensive method of prawn culture is practised in the two coastal districts viz., Dakshina Kannada and Uttara Kannada, involving several hundred acres of lowlying brackishwater areas adjacent to the estuaries. This traditional prawn filteration in tidal enclosoure can be linked to the 'Bheris' prawn culture of west Bengal and 'Pokkali' prawn culture of Kerala. According to IIM, the average annual production of both prawns and fish is about 338 kgs., per ha. out of which prawns account for 86.58% and the fish - 13.42%. The turnover is estimated at Rs. 2893.12/ha. The total estimated fish production from filteration ponds is about 600 MT. The growing awareness about the export potential and profitability of prawn farming has promoted farmers to venture into this field. The State Govt. is very keen that this encouraging trend is followed up through massive extension and training programmes with a view to ensure that scientific prawn farming is taken up on a large scale in order to sustain steady supply of prawns for export and also for domestic consumption.

Scope for Brackishwater Fish Culture :

Karnadaka is endowed with 8,000 ha of brackishwater area- The major brackishwater bodies of the State are *Kali estuary, the Aghanashini estuary, the Venkatpur*

estuary, the Gangavali estuary, the Gangolli estuary, the Hungarcutta estuary, the Sharavathi estuary, the Udayara estuary, the Mulki estuary, and *the Netravathi - Gurupur estuary*. The rivers flowing into the Arabian sea are subjected to tidal influence upto about 15 to 25 kms. inland and the max. tidal amplitude near the river mouth *is 5 to 6 ft.* The important feature in the enviornmental characteristics is the large fluctuation in the salinity (0.5 to 35% ppm.) The coastal regions experience a heavy rainfall of about 3500 mm. in a year.

The brackishwater culture being practised in the lowlying brackishwater areas and Kharlands of the State particulary in Uttara Kannada District, can be regarded as extensive type of culture.

Way back in 1963 - 64, Karnadaka Govt. had launched the Kharland schemes to convert swamps into Kharlands by constucting strong bunds with sluice gates to regulate the water flow and facilitate paddy cultivation. Only after 1970-71, the culture of prawns in the same Kharlands through filteration was started when the farmers realised the economic importance of prawns. The modus operandi of this paddy and fish culture method involves culture of the coarse variety of saline resistant paddy known as 'kagga' in these Kharlands during the rainy season. After harvesting the paddy crop, the same fields are prepared and utilised for prawn filteration till the next monsoon and two to three crops are taken annually. This, apart, there are several hundred acres of Kharlands having bunds with sluice gates raised by farmers and village panchayaths. It is estimated that about 6640 ha. of Kharlands available in Uttara Kannada Dt. Kharlands are also available in Coondapur, Udupi and Mangalore taluks of Dakshina Kannada Dt. Kumta and Coondapur taluks account for the major share of Kharlands in Uttara Kannada and Dakshina Kannada Dt. respectively. Salt pans are also being utilised for prawn culture to a limited extent.

Prawn and fish seed Resources :

The estuaries of Karnataka are known to harbour the important brackishwater fishes such as mullets, *Etroplus* (pearl spot), *Sillago* (Sand whiting), Perches, *Chanos* (Milk fish), etc., and prawns such as *Penaeus indicus, P. monodon, P. merguiensis, Metapenaeus dobsoni, M. monoceros*, etc.

The seed of *M. dobsoni* is the most abundant prawn seed in the estuaries of Karnataka, next comes *P. Indicus*. These two species forms as potential species for selective stocking in brackishwater culture. Eventhough *P. monodon* is known to occur in the region, the relative proportion of occurance of the seed resources of the species is not known as detailed investigations has not yet been done. Although the Central Marine Fisheries Research Institute has in the past conducted surveys for the assessment of seed resources, only month-wise distribution pattern of different species of prawns could be made known. The qualitative and quantitative assessment of prawn seed resources still remains an unaccomplished task and it has become a serious handicap in the way of scientific prawn farming.

Constraints :

1. Most of the cultivable land including Kharlands is owned by non-fishermen

community. Most of the Kharlands are under the management of tenancy having occupancy rights and are fragmented. Individual holdings are too small. These are cultivated collectively by the farmers and after the harvest of paddy, leased out for the filteration of prawns. The extent of available Govt. owned land being negligble, this has become a serious constraint for the implementation of scientific prawn farming under 'Area Development Programme' under Central sponsorship.

2. Owing to lack of data on the qualitative and quantitative availability of prawn seed much progress could not be made so far.

3. Since the Kharland farmers are left out of the purview of 'Area Development Programme' there is very limited scope for the implementation of the programme.

Schemes in the Pipeline :

1. Under the Central Sector Schemes of Pilot Project for Demonstration of Brackish water Fish Culture, construction of 10.8 ha fish farm has been taken up at Kanasagiri in Uttara Kannada dt. in two stages. The works on the first stage are completed and those of the 2nd stage are expected to be completed by the end of the current financial year. Demonstration of brackish water fish culture will be initiated in the first stage of the farm during 1985-86 and there after in the second stage by taking up monoculture and polyculture of shell fish and fin fish.

In order to successfully implement 'Area development Programme' under the centrally sponsored scheme of Brackishwater Fish farming during 1985-86, 60 hectares of brackishwater area has been selected at Sankuri village, Karwar in Uttara Kannada dt. In the first instance, 31 Nos. of ponds each of 0.8 acre water area are proposed to be constructed along with main and secondary bunds with sluices at a total cost of Rs. 57.65 lakhs. The ponds are to be leased out to the identified benficiaries. The project report prepared by Marine Products Export Development Authority envisages taking two crops of prawn, one of *Penaeues indicus* of three months duration and another of *P. monodon* of 5 months duration. Both the crops are estimated to yield annually 17.25 M. tonnes of prawns valued at Rs. 12.86 lakhs.

It is proposed to enlist the active cooperation and support of Marine Products Export Development Authority, District Rural Development Society, Central Marine Fisheries Research Institute and NABARAD in this endeavour

3. A prawn seed hatchery for production of seed of Tiger Prawn is proposed to be set up either at Majali or at Tadri. Until the hatchery is commissioned, collection of prawn seed from the nature will be done in a well planned manner in order to meet the requirement of seed.

4. Since the centrally sponsored scheme of brackishwater fish farming is modelled on the lines of inland fish farmers development agencies, a brackishwater fish farmers development agency will be set up under the sponsorship of Govt. of India so as to facilitate effective implementation of the integrated programmes.

5. The Brackishwater fish farmers Development Agency will be geared up to

evolve package of broad-based extension and training programmes for the Kharland Farmers with a view to improve the existing prawn culture practice and for others to take to scientific prawn farming.

6. The area development scheme does not provide for assistance to the farmers owning Kharlands. After completion of survey of suitable brackishwater sites for prawn farming, a separate scheme is proposed to be formulated for helping the Kharland owners to take up scientific prawn farming with financial assistance from the State Govt. and financial institutions.

7. Under the aegies of the brackishwater Fish Farmers Development Agency, a prawn farmers co-operative society is proposed to be organised so that the society can effectively tackle the issues such as collection of seed, organisation of seed banks, large scale culture of prawns, marketing of prawns for domestic consumption and for export, operation of hatcheries etc., with financial assistance from NCDC, State Govt. and Govt. of India.

With these proposed programmes, it is hoped that a substantial proportion of brackishwater resources of the State could be juidiciously utilised for scientific prawn farming and it could be possible to adequately augment foreign exchange and generate ample employment opportunities in the rural areas.

PRESENT STATUS OF PRAWN FARMING SCHEMES IN GOA

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Goa has got about 4500 hactares of fallow and marshy lands and about 12,500 ha. of low lying paddy fields locally known as khazan lands. These fields are located all along the major tidal rivers of Goa. Due to high saline conditions of the soil and lack of irrigation facilities, only single crop of paddy is cultivated during Kharif season and the remaining period these fields are lying idle. The existing legislation in force prevent the intake of saline water for pisciculture purposes.

All the paddy fields will have a drain area adjacent to the sluice gate. These areas varies from I hactare to even 50 to 60 hactares depending up on the size of the paddy fields. A traditional fishery by filteration method through the sluice gates exist in these areas and it is estimated that about 1,200 hactares are covered under this category.

The entire brackishwater area available under fallow, marshy and khazan totalling about nearly 18,000 ha. are belonging to either private or communidade, are association of the land lords. The Govt. is not owning even a single hactare of land under the above category. This makes difficult for the Government to put these lands for maximum utilisation. The only alternative is to pursue the owners to put the land for proper utilisation by giving some incentives and other infra structure acilities required.

The income from the paddy is very low and not remunerative and as such the majority of farmers prefer to use the fields for prawn farming, But the statutory rules in force prevent the said activity. There fore there is a growing tendency to illegally flood the fields by even deleberetely breaching the bundhs.

Though the Government has taken a policy decision to encourage prawn culture in the paddy fields during the lean season, to facilitate the same, the Tenancy Act is to be suitably amended. The tenancy Act itself is challenged and the issue is at present pending with the Supreme Court.

The Department of fisheries has set up a brackish water fish farm having about 5.0 hactares of water area. The experimental culture of brackishwater varieties of fish and prawn is carried out in this farm, and it is used for demonstration and training purpose to the prospective farmers. This was the only scheme existing for brackishwater fish farming till the VI th Plan period.

More emphasis is given in the VIII th Plan for the promotion of brackish water fish culture for which the following schemes are included.

1. Centrally sponsored Scheme for development of brackish water farming.

The Govt. of India has already sanctioned the above centrally sponsored scheme. Under which about 82 ha. out of a total of 266 ha. acquired by the Government is being developed. The project report, plan and estimates etc has already been prepared and the work is expected to commence duringthis year itself.

A prawn seed hatchery is contemplated under the centrally sponsored scheme and the work of which also is expected to commence soon.

2. Financial assistance for fish culture.

A provision of Rs. 25/- lakh is made during the VII th plan for extending financial assistance by way of subsidy to the private enterpreneures for developing their areas for brackis1 water fish farming, A target of about 1,000 ha. are fixed for the plan period.

3. Training programme.

The existing facilities at the fish farm will exclusively utilised for training, demostration and extension.

STATUS PAPER ON BRACKISH WATER PRAWN AND FISH CULTURE IN KERALA

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Schemes for the development of prawn and fish culture in brackish water areas initially commenced during the Sixth Plan period in Kerala. A few brackish water farms were set up in the state sector at various places. These farms however failed to achieve any significant results on account of rigidities in management, extensive poaching and inadequate control. The Departmental form of undertaking was found to be inadeguate for meeting the requirements of commercial prawn farming.

It is generally accepted that the State has tremendous potential for scientific aquaculture. The major areas where scientific aquaculture can be started are the estuaries of the rivers and their lower reaches within the tidal influx, mangrove swamps and marshes together covering about 42 lakh hactares. The important brackishwater lakes of the state from the north to south are the Kavery, Kottapuzha, Valapattanam, Korapuzha, Voliangode, Cranganore, Parur, Vembanad, Kayamkulam, Ashtamudi, Paravoor, Edavanadayara, Ahgengo, Kadinamkulam, and Veli. Of the total estuarine and brackish water resources, available about 1.22 lakh hectares distributed in various regions are considerd to be areas suitable for brackish water fish and prawn culture.

Barring about *6000 ha.* of law lying fields adjacent to the backwaters, the brackish water areas in the state are presently used for capture fisheries, supported by a veriety of fixed as well as free gears. Brackish water fish and prawn culture is practiced on commercial scale in about 6000 hectares of low lying fields. This culture operation is an age-old avocation practised seasonally in most fields and perennially in a few. Seasonal culture is carried out in fields where a special strain of paddy is cultivated once in a year. These fields were once part of the backwaters and have been reclaimed for paddy cultivation by construction of dykes. In these fields, prawn culture and paddy cultivation are practiced in rotation, prawn from mid-November to mid-April and paddy from June to September-October. After the harvest of paddy the fields are prepared for prawn culture by strengthening the bunds & fixing sluice gates. During the spring tide the sluice gates are kept open to let in prawn seeds along with a heterogenous collection of other marine animals including fish. During the neap tide a screen is placed at the sluice gate

to prevent escape of the prawn. The prawn and fish fry thus trapped are allowed to grow for a period of 2 months before the harvesting is started. Harvesting is a continuing process during full moons and new moons in succession throughout the remaining culture period. The size of the seasonal fields in which prawn culture is practised range from about one-half to forty hectares. The average annual production of prawns in these fields is reported to be in the range of 100-600 kg./ha. In most places the predominant species produced is *Metapenaeus dobsoni* followed by *Penaeus indicus*. *M. monoceros* and *P. monodon* are also available in very limited quantities. This kind of traditional culture is advantageous from the point of view of the farmers, as it involves only limitad investment. But, viewed from the angle of scientific culture, the prevailing system is inefficient as it does not involve selective stocking of seed, initial removal of predators, manuring and feeding to enable the prawn to grow to maximum size. It, however, holds out the promise that, given necessary support, by way of quality seed, credit and technical guidance, there is immense scope for prawn culture.

In the Seventh Five Year plan of the State, emphasis is given to diversification of fishing in the marine sector and large scale culture activity in the inland sector with a view to bring about substantial increase in production. The overall out look is very promising. Empirical knowledge and survey reports suggest that the offshore and deep sea areas of the state have immense stocks of exploitable resources. The needed innovations in capture technology is proposed to be introduced, if need be with tie-up arrangement with countries possessing the technology for effectively tapping the resources. In the inland sector, the prospects for large-scale culture of prawns has brightened, with improvements in the hatchery technology for seed production.

There are a number of special features that render Kerala backwaters well-suited for brackish water fish and prawn culture. These include:-

(a) Low tidal amplitude making it possible to use relatively simple dykes and bunds,

(b) Low prevailing temperature and humidity that reduce evaporation loss consequent high salinity,

(c) Location outside the cyclonic belt obviating probable risk of damage to the farm dykes and bunds,

(d) A tradition of prawn filtration which has proved the commercial prospects of prawn culture,

(e) Existense of established trade channels for selling the product to exernal markets and

(f) A well-educated technically competent workforce who can easily learn and develop sophisticated technology for culture as well as processing.

Farmers in the brackish water area already posses a traditional technology of paddy-cum-prawn culture. Such farms are mostly situated in Ernakulam disirict. There are similar identified areas under private ownership in Trichur, Malappuram,

Kozhikode and Cannanore which are not suitable for paddy cultivation on account of depth, but ideal for prawn culture. In Ernakulam District itself there is known to be possibility of bringing more area under perennial and seasonal culture. The Central Marine Fisheries Research Institute, Cochin, after making an evaluation of the current traditional culture practices, in 1978, demonstrated experimentally that, through selective stocking and a longer culture period, substantial improvement can be brought about in the system both in terms of quantity and quality of the crop. As per the observations of the institute, it is feasible to take two crops in the seasonal fields and three in the perennial fields under scientific culture, the average yield being 1000-1500 kg. ha./annum of *P. Indicus*.

The main element of brackish water prawn and fish culture are as enumerated below:-

1) Extensive survey of areas.
2) Intensive survey.
3) Preparatjon of project reports.
4) Financing.
5) Construction works.
6) Prawn culture.

Extensive survey involves identification of all areas prima facie suitable for prawn culture and finding out the nature of the lands. Through extensive survey an exhaustive list of all araas would be available. Other relevant information, such as the ownership of the land, would also be gathered during the survey. Major schemes for development of prawn culture can be drawn up by short listing the areas identified during the extensive survey. Extensive survey is conducted by sending experienced officers of the Fisheries Department to the field for identifying such areas has been completed in the districts of Alleppey, Kottayam, Ernakulam and Trichur. The areas initially identified are as follows:-

District	Culturable area (in ha)
1. Trichur	942
2. Ernakulam	7,761
3. Alleppey	1,500
4. Kottayam	1,270
Total	11,473

Extensive survey has now been commenced in Cannanore District.

Tha next stage would be the conduct of intensive survey. The purpose of the intensive survey is to exclude those areas which are not suitable for prawn culture or which would not yield sufficient return commensurate with the cost of development. At this stage, a technical team, consisting of a marine biologist, a chemist-an engineer, and a surveyor would visit the area and take water and soil samples. As part of thls exercise acidity, salinity, alkalinity, flora and fauna of the area, dissolved oxygen content, temperature and the variability of these factors in different seasons would be assessed. This work has now commenced in the four districts where extensive survey has been completed.

After the intensive survey is completed detailed project reports have to be prepared for each area. Engineering and biological details are included at this stage and

detailed enginering survey is conducted. Brief details regarding the engineering survey to be conducted are given in Annexure - 1.

Detailed project reports for five brackish water farms in kerala have already been prepared and submitted to the Government of India. The farms to be developed under the Centrally Sponsored Area Development Programme are Ayiramthengu, Palaikari, Narackal, Malippuram and poyya. A project is now under preparation for developing brackish water prawn and fish culture in poyyil and Perumbalam Kayal. The complete renovation of the Kodappuram farm was under taken using funds available under Flood Relief. The main features of the schemes already sanctioned by the Government of India are indicated in Annexure II.

Simultaneously with the development of location specific schemes, we also realised the need for developing a major scheme for speeding up the process of development of brackish water prawn and fish culture. With the present organisational base, it would be impossible for us to develop brackish water prawn and fish culture on a very extensive scale in the foreseeable future. Growth would continue to take place at the rate of a hundred to two hundred hectares each year, which would mean that it will take us many decades to achieve any significiant result. It is therefore necessary to conceive of a development programme that would considerably speed up the rate of progress achieved in this sector. The present practice of pulling out staff and equipment from one sector and putting them on to project formulation and implementation on an adhoc basis for a limited period of time will not result in any significiant growth. We have therefore to plan for a massive programme for prawn and fish culture to be taken up over a period of five to seven years and to create an organisation which is capable of producing such growth. (Accordingly the Fisheries Department in Kerala got down to the task of preparing a project for commencing brackish water prawn and fish culture over 15000 hactares of land in Kerala). This scheme has now been sent to the Government of India for onward transmission to the World Bank for assistance. It has already been cleared by the Ministry of Agriculture and forwarded to the Department of Economic Affairs and it is expected that it will shortly be posed to the world Bank for assistance. The main features of the project formulated by the Department are given in annexure III.

Even without World Bank Assistance, however, substantial growth in the development of brackish water fish/prawn culture can be ensured using funds available with various institutional agencies in the country. Brackish water prawn/fish culture development in the private and corparate sectots can be developed using Bank loans which will be refinanced by NABARD. A scheme in this regard for development of about 300 hectares of brackish water area in cannanore district has already been prepared by the State Co-operative Bank with the assistance of the Fisheries Department and Forwarded to NABARD. Farms in larger areas can be established in the form of Co-operatives with 80 per cent loan assistance from the National Co-operative Development Corporation. Funds available under

the Rural Landless employment Guarantee Programme, the Integrated Rural Development Programme and the Western Ghat development programme can also be utilised for meeting the cost of capital works for brackish water prawn and fish culture. A few schemes are under preparation for financing under the Western Ghat development programme in Kerala There are agencies like the Peoples Action for Development (India) under the Ministry of Agriculture, which would finance the activities of voluntary agenceis taking up prawn and fish culture and other development schemes. In recent months the corporate sector has shown considerable interest in setting up joint venture Projects with State Government agencies for prawn and fish culture including seed production. Such joint venturc projects will secure foreign technology from countries which have already achicved considerable increase in productivity of brackish water fisheries. One such scheme in Kerala is now in an advanced stage of processing. Finally there is the centrally sponsored area development programme which provides for 50 per cent assistance from the Goverment of India and 50 per cent from the State Government, under which five farms are presently under construction.

The work of construction of brackish water farms in Kerala has been entrusted to the Harbour Engineering Department which has developed expertise in aquaculture engineering. We have also been able to secure the assistance of the Central Institute of Coastal Engineering for Fishery, Bangalore, who have been extremely helpful to us in formulating projects for brackish water prawn and fish culture.

So far as inputs are concerned t major constraint is usually seed. Ker is relatively fortunate in this area, sin the Regional Shrimp Hatchery at Azhiko first set up in 1978 under the guidan of Mr. K. H. Alikunhi, then Fisher Development Adviser to the Governme of Kerala, has been functioning effective The seed production at the hatche depends entirely on the collection wild spawners, eventhough limit success was achicved last year throu eye-stalk ablation of *P. indicus*. Se prodution at Azhikode has achiev steady progress through the years indicated in Annexure IV.

The hatchery has been facing son problems, which have limited productio One important problem has been lo salinity in the adjoining estuary fro which water is drawn from the ons of the monsoon until about Octob each year. This automatically restri seed production of *P. indicus* & *P. monod* to about six months, since there is likelihood of demand for prawn larv after February, as the grow out peri will be too small. In respect of *Mac brachium resenbergii*, the major proble has been high mortality during the zo stage of growth coupled with inadequa live feed (Moina) during the early stag of growth. Moina has to be collect from ponds in the vicinity, since culture would necessitate the develo ment of facilities on a large scale, whi does not seem to be a commercia viable proposition. A new hatche which will be locationally far super to the one at Azhikode is proposed be set up at Moplah Bay in Cannan District during the current financial y

under the centrally Sponsored Area Development Programme. The main features of the proposed hatchery at Moplah Bay are indicated in Annexure V. Simultaneously, the Azhikodc hatchery is being expanded by developing additional facilities in the adjoining boatyard, which is presently not functioning. It is expected that the prawn seed supply problem can be effectively handled by these two hatcheries. Not much work has been done in the collection and culturing of brackish water fish species, like *Chanos chanos, Mugil cephalus* and *Etroplus suratcnsis,* but we propose to make a beginning during the current year.

The main problem that we encounter in brackish water prawn and fish culture is lack of a sufficiently strong organisational base which could undertake development of prawn and fish culture over a period of time. There are a large number of private entreprenuers who are willing to take up prawn and fish culture in areas owned by them. There are large areas which coule be developed on a co-operative basis. These areas could be brought under prawn culture, f given technical assistance including engineering plans - can be provided on continuing basis, and if some monetary ncentive can be given to persuade farners to invest the sizable amounts required for the development of prawn ulture. It is also important that the iability of the project is fully established and demonstrated to them. As far s the co-operative sector is concerned, he problem again lies in our failure to dentify areas and to immediately undertake detailed investigation. The solution would therefore lie in strengthening the organisational base and in preparing long term development plans.

There is a vast reservoir of technical ability available in this country attached to various institutions. There are a number of institutions which have undertaken studies in various aspects of brackish water prawn and fish culture These institutions include the Central Marine Fisheries Research Institure, Central Inland Fisheries Research Institute, Marine Products Export Development Authority and Coastal Institute of Engineering for Fishery, besides, the State Departments of Fisheries. The time has come when it is necessary to pool together this talent for the prepation of long term development plans and for undertaking detailed project studies. Government of India in the Ministry of Agriculture has already taken a very important step in this direction. It has entrusted to the Indian Institute of Managemeht the task of preparing project reports for development of brackishwater areas in all the Maritime States. It has also entrusted to Coastal Institute of Engineering for Fishery, Bangalore the task of preparing projet proposals for strengthening the technical wings of the Fisheries Department. These are very important new developments which hold much promise of quick development of brackish water prawn and fish culture.

The Marine Products Export Development Authority's scheme for providing subsidies for private farmers and co-operatives taking up prawn culture

on scientific lines would definitely induce faster development in this area.

I would also suggest that we could consider establishing a Task Force in each State consisting of experts from all the Central Institutions and the State Government for planning and development of brackish water prawn and fish culture. This Task Force should also be given the powers for pooling together the available resources for conducting intensive survey and preparation of detailed project reports. The Task Force will also review the progress of works already taken up and provide technical inputs to the field officers including programmes for upgradation of technical skills, This would go a long way towards expediting progress in this hitherto neglected sector.

ANNEXURE — I

ENGINEERING SURVEY
INVESTIGATION AND COLLECTION OF DATA

The engineering aspects to be looked into while establishing a Brackish Water Fish Farm are the survey, investigation and collection of data, preparation of lay out, disign and construction of farms and its water management. Detailed analysis on survey, investigation and collection of data are essential for running a brackish water fish farm successfully. The following are the salient points to be looked into in this regard.

I. 1. The Survey

This can be classified mainly into four :

1. Aerial Survey
2. Topographic Survey
3. Hydrographic Survey
4. Contour Survey

1. Aerial Survey :

A bird's eye view of the area may be taken first to study the general features such as climatic conditions, position, elevation, water spread area etc.,

2. Photographic Survey :

The survey is conducted to include the natural features such as, rivers, hills, streams, lakes, ponds, and the artificial features, such as, roads, buildings, canals, bridges etc., of the area.

(a) Selection of datum

The datum is a common reference laying to which all the land levels, tide levels such as water levels and soundings are referred in the course of the survey. The datum at site can be arrived at by transfer of datum from the nearest standard bench mark.

(b) Transfer of datum from the nearest standard bench mark.

The topography and tide levels at the site are the two important conditions for setting and planning of any brackish water fish farm. Topographic features and tide levels referring to the same datum are necessary to plan and arrive at the appropriate levels of pond beds, drainage channels etc., A datum selected should have some co-relation with that of the nearest standard port so that a high water levels on any particular day at the site can be easily co-related by referring to Indian Tide Tables.

(c) Triangulation .

Having established datum for vertical control the next thing to be done is to

establish the horizontal control. There are various methods by which triangulation survey can be conducted. It can be done using theodolitie, compass etc., The main components of traverse survey are selection of Triangulation stations, measurments of base lines, angular measurement between stations, Calculation of distance, measurements of bearings and connecting the levels of the triangulation of stations with the datum.

(d) Selection of Triangulation stations.

The triangulation stations may be selected keeping in view'

(i) The station should be intervisible

(ii) The station should approximately form equi-lateral triangle and

(iii) The internal angles should be between 30 and 120°.

(e) Measurement of base line.

This can be done using standard tape by applying corvection for temperature pull, catinery slope etc., to the measured length,

(f) Angle measurement :

Angle between stations can be measured using theodolite, compass etc.,

(g) Measurement of bearing :

The bearing of any line can be measured using prismatic compus. The true bearing can be obtained by applying correction for magnetic deviation, having known the true bearing of a line and the distances of all lines and the included angles.

(h) Connecting the levels and the triangulation stations, with datum,

All the levels of the triangulation stations should be connected to the datum by fly levels.

3. Hydrographic Survey

Hydrographic survey of the area should be known in order to ensure that sufficient quantity of water required for the running of the farm enters the area. The bed level of the area has to be adjusted in such a way so as to enable to drain the ponds periodically. The sounding of the area can be done using lead lines and fixing the positions of the sounding by a pair of theodolite stations on the bank or by cross ranging methods depending upon the site conditions. The water level should be recorded at the time of sounding.

4. Contour Survey.

After taking the soundings of the area and the levels on the ground, the contour map of the area may be prepared in order to design and efficient and economical lay out of fish farm. The contours can be prepared at intervals of 30, 50 cm.

II. Investigation and Collection of Data ;

The following data to be collected after engineering investigation for selection of site for fish farms:-

(a) Studies on water shed and flooding records.

(b) Tidal variations in the locality.

(c) Area available.

(d) Water properties such as salinity, turbidity, pollution pH, temperature, depth, dissolved oxygen, alkalinity, etc.,

(e) Soil properties, such as, load bearing capacity, pH, salinity, permiability, moisture content, bulk density, specific gravity, cohision, grain size analysis, optimum moisture content etc.,

(f) **Climatic Conditions**

Rain fall
Temperature
Prevalent wind
Rate of evaporation.

(g) **Vegetation :**

Some vegetated area within the pond system is required.

(h) Availability of management and labour man power.

(i) **Marketing Problem :**

Ice Plants.
Cold Storage Plants.
Prevailing Prices of products etc.,

(j) Accessibility and infrastructure, such as Roads, Harbours, Air Ports, Hospitals etc.,

ANNEXURE—II

BRACKISH WATER FISH FARMS

MAIN FEATURES

Salient Features :

1. Poyya.

Gross area of land	:	85.83 hectares
Net water spread area	:	48 hectares
Estimated amount	:	Rs. 30 lakhs.
No. of ponds	:	24 @ 2 ha. each.
Estimated production per year on completion of the fish farm :		
800 kg./ha./of prawn @ Rs. 50 per kg.	=	Rs. 19.2 lakhs.
250 kg./ha./of fish @ Rs. 10 per kg.	=	Rs. 1.2 lakh
Total return per year	=	Rs. 20.4 lakhs.

Life of the farm	:	20 years.
Operating cost per year	:	Rs. 7.22 lakhs.

2. Palaikari :

Gross area of land	:	48 hectares.
Net water spread area	:	40 hectares.
Cost estimate for construction of the farm	:	Rs. 20 lakhs.
Life of the project	:	20 years.
Revenue expected on completion of the fish farm :		
a) Prawn @ 600 kg./ha./year @ Rs. 40 per kg.	=	Rs. 9.6 lakhs.
b) Fish at the rate of 250 kg./ha./year @ Rs. 10/kg.	=	Rs. 1.0 lakh.
Total revenue expected on completion	=	Rs. 10.6 lakhs.
Operating cost per year	=	Rs. 3 lakhs.

3. Ayiramthengu :

Gross area of land	=	20 hectares.
Net water spread area	=	13 hectares.
Estimated cost of construction.	=	Rs. 12 lakhs.
Revenue expected on completion of the project :		
a) Prawns @ 800 kg./ha./year @ Rs. 50/kg.	=	Rs. 5.2 lakhs.
b) Fish @ 250 kg./ha./year @ Rs. 10/kg.	=	Rs. 0.325 lakh.
c) Yield obtained from coconuts standing on the bund.	=	Rs. 0.25 lakh.
Total	=	Rs. 5.775 lakhs.
Operation cost per year	=	Rs. 2.22 lakhs

4. Narakkal and Malippuram :

Gross area of land	=	50 hectares.
Net water spread area	=	40 hectares.
Estimated cost of the construction.	=	Rs. 45 lakhs.
Life of the project	=	20 years.
Revenue expected on completion of project :		
a) Prawn @ 800 kg./ha./year @ Rs. 50/kg.	=	Rs. 16 lakhs.
b) Fish @ 250- kg./ha./year @ Rs. 10/kg.	=	Rs. 1 lakh.
Total	=	Rs. 17 lakhs.
Operation cost per year	=	Rs. 6.6 lakhs

ANNEXURE — III

MAIN FEATURES OF THE KERALA FISHERIES DEVELOPMENT PROJECT

For

PRAWN CULTURE

According to available estimates Kerala has a potential of 1.22 lakh hectares of brackish water area amenable for development of prawn/fish culture. As against this the area presently brought under culture consists of around 6000 ha. of seasonal prawn filtration fields, used for raising alternate crops of paddy and prawns, and about 65 ha. of farm owned by the Department of Fisheries. Scientific culture of prawns is highly remunerative, but because it calls for heavy initial investments a programme for development of large scale culture can be conceived only with substantial assistance from bilateral funding agencies like the World Bank. The present project is prepared with the objective of posing it to the World Bank for funding assistance.

The Project.

The project proposal is for developing 15000 ha. of otherwise unutilised or underutilised brackishwater areas into prawn culture farms over a period of seven years. Out of the 15000 hectares 10000 ha. will be under the private sector and the remaining 5000 under the public sector. Along with prawn culture, planting of coconut seedlings, at the rate of 50 per hectare on the outer bunds of the farms to be set up, is also proposed under the Project as a uniform practice. The other essential complementary components of the project are:-

1) five prawn hatcheries
2) three prawn feed manufacturing units
3) processing and marketing facilities in the form of 35 peeling sheds, three freezing-cum-storage plants and 15 insulated vans and a marketing unit.
4) a research wing and laboratories attached to the hatcheries and a programme for training.
5) an Extension Unit.

Cost

The overall investment of the project is estimated to be about Rs. 134.7 crores. The breck-up is as shown below :-

	Rs. Crores
1) Setting up of farms in 15000 hectares.	123.5
2) Hatcheries (5)	3.5
3) Feed Production Units (3)	1.5
4) Processing and Marketing	3.4
5) Research, Training and Extension.	1.4
6) Administration	1.4
Total	134.7

The funding pattern anticipated is:

1) World Bank (80%)	94.0
2) State/Union Government	10.0
3) Commercial Banks	16.0
4) Farmers contribution	14.5

NABARD will be the fund channelising institution within the country.

Benefits

1. a) In terms of additional production of prawn	15250 tonnes
b) and production of coconuts	48 million nuts
2. Earnings from export -	Rs. 94 crores
3. a) Employment generation during the construction period -	180 lakh man days
b) and Regular employment -	47000 man years.
The I.R.R. of the integrated project is -	38 per cent.

Organisation

The project will be implemented jointly by the Department of Fisheries and the State Co-operative Fisheries Federation, the latter bearing the major brunt. A project administration unit under a Chief Project Co-ordinator will be created for co-ordinating the implementation of the component projects, An Engineering wing consisting of a Division and five Sub Divisions will also be created to take care of the civil works involved. The 5000 hectare farms to be set up in the public sector will be later leased out to co-operative societies of inland fishermen at the rate of 250 hectares per Society.

ANNEXURE — IV

PRODUCTION OF PRAWN SEED AT REGIONAL SHRIMP HATCHERY, AZHIKODE FROM 1978-79 TO 1984-85

Production (in lakhs)

Year	P. indicus	P. monodon	M. rosenbergii.	Total
1978-79	—	—	—	10.00
1979-80	43.04	0.63	0.06	43.73
1980-81	27.61	2.97	1.12	31.70
1981-82	35.79	0.11	0.59	36.49
1982-83	35.16	1.70	0.59	37.45
1983-84	47.98	5.57	0.64	54.19
1984-85	49 03	7.26	0 23	56.52

ANNEXURE — V

SHRIMP HATCHERY AT MOPLA BAY
(MAIN FEATURES)

1. Salient Features : The main objectives are :

1) Commercial Production of seeds of Penaeid prawns.
2) Production of Juveniles of fresh water prawns.
3) Intensive race way culture of post larvae of the prawns to stockable size.
4) Studies on induction of maturity of prawn by eye ablation.

Estimated cost of establishing the hatchery. Civil Works.

a) Cost of construction of feed room, machine room, insitu filter, platform etc., — Rs. 6.4 lakhs.

b) Installation of machinery and equipments such as power generator, air compressors, water pump, fibre glass tank, plastic pool etc., — Rs. 4.1 lakhs.

Total — Rs. 10.5 lakhs.

c) Production of prawn seeds

The hatchery will commence production of prawn seeds from the first year of its application. The following are the details of production expected.

Year	Production in Million			Total
	P. indicus	P. monodon	M. rosenbergii.	
1.	15	2.5	0.5	18
2.	15	2.5	0.5	18
3.	15	2.5	0.5	18

The total operating cost per year = Rs. 3.69 lakhs
The total income on sale of prawn seeds = Rs. 5.5 lakhs
The net profit per year is = Rs. 1.81 lakhs.

PRESENT STATUS OF PRAWN FARMING IN TAMIL NADU

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1. Introduction.

Tamil Nadu has a coast line of 1000 kms spreadover in the eight coastal districts viz. Madras, Chengalpattu, South Arcot, Thanjavoor, Pudukkottai, Ramanathapuram, Thirunelveli and Kanyakumari. Based on the grographical conditions the Tamilnadu coast is classified as

i) Coromandel coast (ii) Palk bay and iii) Gulf of Mannar.

The "Coromandel cost" extends from Pulicat lake in the North to point Calimer in the south in the Thanjavoor District. This coast is Characterised by heavy surf and turbulant conditions. The major river in this sector is Cauvery with its distributaries. Other important rivers draining in this sector are Araniar, Courtallayar, Adayar, Palar, Gadilam, Paravanar, and Vellar. They are seasonal in nature. Due to turbulent breakers and consequent sand drift in the sea outside, most of the estuarine mouths in this area are prone to closure for varying periods of four to six months in a year.

"Palk Bay" is the middle sector extending from point Calimer in the North to Mandapam in the south. This sector is characterised by calm sea and shallow coast. The main rivers draining in this area are Vaigai and Kottakarai. Owing to calm nature of the sea the bar-mouth remains open for most parts of the year.

The third sector "Gulf of Mannar", extends from Rameswaram in the North to Cape Comerin in the south. Tambaraparani is the main river draining in this sector. Expecting in Tambaraparani all all the bar-mouths in the sector remain closed for a period from four to six months in a year.

Apart from this, a connection between Vellar river and the Coleroon in South Arcot District with extensive network of inter connecting canals from thick mangrove forests in Killai area contributing a unique brackishwater environment.

Brackishwater environments such as lakes, lagoons, marshes, mangrove swamps and tidal flats are the presently available resources that are under-exploited, which can be developed into brackishwater farms not only for increasing the fish production but also to generate employment potential, improve rural income and to earn foreign exchange.

2. BRACKISHWATER RESOURCES.

2.1. Available brackishwater areas.

In Tamilnadu, the area of brackishwater spreads has been assessed at about 56,000 ha, comprising nearly 52 estuaries, and backwaters, lagoons, lakes etc. The extent of lowlying brackishwater areas suitable for prawn farming has been estimated to be 15,000 ha. The district-wise and ownership-wise break-up of these areas are given below :-

TABLE - 1

Details of Brackishwater Resources of Tamilnadu (Anon '80)

Name of the District	Total area of Brackish-water spread (owned by government)	Extent of low lying areas to brackish-water spreads	Ownership			
			Rev. Porom-boke	Salt Dept.	Fore-st Dept.	Rail way.
Chengalpattu	14,841 000	2,662.90	2,621.70	41.20	—	—
South Arcot	8,072.000	2,703.93	1,694,08	461.00	540.00	8.85
Thanjavur	31,425.65	7,297.47	3,031.47	709.68	3,556.32	—
Pudukottai	—	247.00	143.78	50.50	52.72	—
Ramanathapuram	874.22	1,385.27	1,212,52	172.75	—	—
Tirunelveli	401.25	565.62	1,565.62	—	—	—
Kanyakumari	265.25	18.25	18.25	—	—	—
Total	55,879.37	14,880.44	10,287.42	1,435.13	4,149.04	8.85

2.2. Seed Resources:

Although there was regular programme for chanos and other brackishwater seed collection in Mandapam and other areas since 1940, actual systematic seed resource survey has been initiated only a decade age and that too only for prawns *Evengeline, 1969, Subramaniam and Rao, 1968, Evangeline and Sudakar, 1972. Muthu, 1973, Gopinath, 1978, Victor Chadra Bose etal 1978 and 1980*). Since there is no organised seed collection in the estuaries and backwaters of the state, the natural resources were not properly tapped All the observations made during the surveys revealed that the postlarval abundance of *Penaeus monodon* is very much less than that of Penaeus indicus. Details regarding the exact quantity of post larvae and juveniles of these prawn species available for the entire Tamilnadu coast are wanting. However the available

information indicates the possibilities of organising prawn seed collection in most of the estuaries.

The details of species and seasons of abundance of prawn seeds available in different estuaries of the state are given in Annexure - I. As far as fish species are concerned the survey has not been properly conducted.

The prawn seed requirement for bringing in 1000 hectares of cultivable backwater areas of the state would be 200 million. The seed requirment will be even more if additoanal areas are brought under cultivation. Therefore, it is doubtful whether the seed availability from the natural sources would be sufficient to meet even the immediate demand.

3. Initial Development Programmes.

Prawn culture in salt pans of Manakkudi region was practiced by local fishermen from times immemorial (Suseelan, 1975). First Marine fish, farm of the country was established in Krusadai island as early as in 1940 for chanos culture. Realising the need to utilise backwater for scientific farming and also to assess the prospects of brackishwater farming, government of Tamilnadu has established a brackish-water fish farm at Santhome, Madras in 1956 and subsequently more number of coastal farms at various places were constructed for aquafarming of brackish-water fishes and prawns. All the ponds constructed were undrainable ones as the pond bottom was below the mean sea level, which seldom retain the required water level by using the available tidal influence. The production obtained from these ponds were encouraging. The details of various farms are given below.

TABLE - 2.

Details of Departmental Brackishwater fish farms of the state.

Year	Place	No. of Ponds	Details
1956	Santhome (Brackishwater Fish Farm)	8	Two 1.14 and 1.5 ha. rearing ponds Six 0.1 ha. nurseries Two 0.095 ha. nursery ponds.
	Adayar (Estuarine Fish Farm)	8	Four rearing ponds and four nurseries.
1963	Manakudy	4	Three ponds of 0.2 ha. and one large reservoir.
1963	Portonovo	6	Six ponds of 0.2 ha in area.
1978	Marakkanam	2	Two ponds of 0.2 ha.
1979	Pulicat	4	Four 0.15 ha. rearing pond.
1980	Kovalam		Construction commenced but later on handed over to Central Marine Fisheries Research Institute,

The most important consideration of brackishwater fish farming is that the ponds should be able to be filled and emptied by the tides for maintaining pond productivity, water quality and ideal pond bottom. This in turn depends on the tidal amplitude. Because of low tidal amplitude (less than one meter), many of the smaller estuaries of the state have become unsuitable for farm construction and most of the farms constructed in some estuaries, shown in Table - 2 are with stagnent ponds. When the tidal range is insufficient pumping of sea water is resorted to by using diesel electric pumps. Of course this may involve a lot of expenditure on installation and maintenance. Substantial amount have also been spent initially for constructing the bunds of the ponds, water supply channels and for installing the other water management systems

Seepage of pond water through bunds and bottom is an important problem which demands continuous pumping of seawater to maintain water level in the ponds in most of the places, especially where the tidal amplitude is very low and the bottom soil is sandy.

Initially the management problems in prawn farming in these ponds were found to be serious and low productions only were achieved.

3.1. All India Coordinated Research Project.

To develop the technology of brackishwater fish farming with its economic feasibility and for transfering the technology to farmers, the Indian Counc of Agricultural Research sanctioned th All India Coordinated Research proje on Brackishwater Fish Farming Tamilnadu utilising the facilities at th Santhome Fish Farm in Madras city with 75% financial assistance. Sinc 1.4.74 the Santhome brackishwater fis farm was utilised for conducting ex periments based on the following researc programmes of the Indian Council Agricultural Research. Some of th worth mentioning achievements of th All India Coordinated Research Proje are:

P. monodon stocked at a rate 20,000 per ha. in 1.12 ha. pond yielde a production of 514.7 kg/ha 80 da with an average size of 169.5mm 33.4 gms. The stocking size was 42 mm 0.5 gms. The survival was 79.8 (Sundararajan *et al*, 1978).

With *P. indicus* stocked at a ra of 70,000 ha. in the 1.14 hectare po a production of 682.450 kg ha 110 da with a survival of 97.25 percent w achieved. The average size and harve was 115 mm 10.0gms. (Srinivasal *et* 1984)

In polyculture systems with tw crops of prawns and one crop of M fish a total production of 1111 kg of *P. indicus* (in two crops) and 1085 k of *Chanos Chanos* (in one crop) we harvested in 5 months rearing perio Some of the results achieved in the fa are given in Annexure-2.

The encouraging results achieved the Santhome brackishwater fish fa happened to be the stimulating fac

the large scale mushrooming of vate prawn farms in Tanjore, South ot and Chengleput Districts. Because non-observance of proper culture te- ology as desiminated by the Fisheries partment most of the private farms ed up in failures with production s not commensurate with the inputs.

2. Performance of Pirvate Farms.

As already stated the results obtained the Santhome farm and interest evinced the Collector of Tanjore, induced ny farmers to enter in this field thout basic knowledge on farming. out 50 farms covering 70 ha. of ter spread were established mainly the districts of Chingleput, Tanjore d South Arcot (Anon 1980). Several re the wrong steps taken by the mers in pond construction, species lection and water management. Some mers, due to worng identification of ecies have stocked thier pond with ysids, Acetes, Metapenaeids and other economical varieties. While pumping water there was no measures to vent entry of predators and unwanted ganisms; excess dumping in of manure d feed which ultimately spoilt the ter quality and excessive water loss ough seepage as some ponds were nstructed in sandy soil are the major sons for the failure of private entre- neures during 1978 to 1980. Even ne of the large farmers and big bu- ess houses who owned brackish- ter farms met with the same fate.

3. Training and Demonstration.

3. 1. Training programmes.

To educate the private farmers and bring more areas under farming the state fisheries department conducted a series of one month training courses in 1978. The training course embraced both theoritical and practical aspects of brackishwater farming. Intensive practical training was given to selected fish farmers by taking them to the various private and public sector brackishwater farms of the state. Totally 80 persons were trained under this programme.

In 1979 a similar training programme was organised for educated unemployed youth under the scheme 'TYSEM' (Training of Rural Youth for Self employment). This training was imparted in various brackishwater centres like, Pulicat, Madras, Portonovo and over 500 youths were trained. The trainees were paid a stipend of Rs. 75/- during the training period of one month. Those who have completed the training were awarded certificates and are in a position to take up farming with initial technical help from State Government.

3. 3. 2. Demonstration Prawn Farms.

The Indian Council of Agricultural Research had organised 'Lab to Land' programme during their "Golden Jubilee" year (1980-81). Under this programme a number of private farms were adopted and subsidies upto Rs. 500/- per farmer for purchase of seed, manure and feed were made available for promoting the brackishwater farming activities.

During the year 1979 Government accorded sanction for the construction of brackishwater ponds to demonstrate the farming practices. As on date 10 domonstration prawn farms are functioning. As per the current level of

technological development it has been found possible to harvest 500 kg/ha/crop and two crops per year. Owing to low tidal amplitude all the ponds have been constructed as pump-fed ponds. The location of demonstration farms in Tamil-Nadu are detailed in the Table 3. Seeds are collected from nearby sources to stock the ponds. The Fisheries Technological Station, Tuticorin supplies formulated feed which is supplimented with other feed available locally.

TABLE - 3

Details of Demonstration Ponds.

Sr. No.	Place	District	No. of ponds			
			Nursery		Rearing	
			No.	Area	No.	Area in ha.
1.	Pulicat	Chengalpattu	—	—	1	1.6
2.	Vanianchavadi	Chengalpattu	4	0.2	2	1.0,0.8
3.	Portonovo	South Arcot	2	0.1,0.5	2	0.65
4.	Thondiakadu	Tanjore	2	0.01,0.02	1	1.88
5.	Eripurakkarai	Tanjore	1		1	1.0
6.	Kattumavadi	Pudukkottai	1	0.04	1	1
7.	Karangadu	Ramanathapuram	—	—	1	1
8.	Kannamunai	Ramanathapuram	2	0.02	1	1.25
9.	Punnakkayal	Tirunelveli	2	0.06	1	1.1
10.	Keelavaipar	Tirunelveli	—	—	1	1

3. 4. Other system for marine prawn culture.

Pen and cage culture of prawns are the different systems practised in different open brackishwater of the state as alternatives to pond culture- Pumpfed ponds are constructed in the margins or the perephery of the back-waters owing to low tidal amplitude. In these areas of low tidal amplitude and high rate of percolation, enclosure method of prawn farming can be tried. Moreover apart from utilising the perephery of backwaters for construction of ponds, the water bodies as such can be utilised by erecting pens or installing floating cages at less initial cost.

3. 4. 1. Cage culture of prawns.

Studies on the culture of prawns *P. indicus* and *P. monodon* in cages were started in the Muttukkadu Lagoon as early as 1973 (Sampath and RamachandraMenon, 1975). At present experiments on cage culture are being conducted at Vanianchavadi by the mariculture unit of the Fisheries Department and also in Ennore backwaters,

Kurusadai island, Portonovo etc. by the Marine Biological station. The sizes of the cages used are $10M^2$ $40M^2$, $50M^2$ and 60M and (Sampath and Ramachandra Menon 1975: Issac Rajendran, and Sampath 1975; Siddharaju *et al*, 1980a, 1980b, Issac Rajendran and Siddharaju 1983). The stocking density ranged from 3/sq. meter for *P. monodon* and from 3 per sq. meter to 15 per sq.meter for *P. indicus*. In genral the survival rate ranged from 61.5% to 100% for *P. monodon* and from 51.5% to 94.2% for *P indicus*. The maximum production of P. monodon was 271 gm/sq. mt./crop of 90-100 days at a density of 11.25 per sq.meter in floating cages and for P. indicus a maximum production of 206.7 g./sq.mt./ was obtained at a density of 20 per sq. meter (Krishnan *et al*, 1983)

Uncertainity in seed supply, suitable feed, unfavourable weather conditions, biofouling, pollution, predators, competitors and diseases are some of the constraints confronting the cage and pen culture operations.

Experiments on Nursery rearing of *P. indicus* and p. mondon have been carried out at Killai in HDPE cages of 10 x 3 x IM, 10 x 4 x 1.5M. and 15x 4 x 1.5M. The stocking density ranged from 6.6, lakhs/ha to 8 3 lakhs/ha. Feeding has been done at 200% of the total body wt. for the first fortnight and 100% thereafter. The survival ranged from 71.2 to 86.3% in 40 days period (Rajappan 1984).

3.4.2. Pen culture.

Although research on brackishwater pen culture for marine prawns was initiated at Kovalam as early as 1977 (Issac Rajendran and Siddharaju 1983), useful information have been obtained by the BOBP supported Pen Culture Project commencing from 1982 in the Killai backwaters in South Arcot District (Anon 1983). Pens are constructed with the following materials; Knotless nylon webbing (10 mm stretched), reinforcement webbing of HDPE 14mm mesh and 36 mesh depth) HDPE rope, Coir rope and Casuarina poles. The cost of 0.5 ha pen (100m x 50m) which can be managed by a family of 4 members has been estimated at Rs. 10,000/- (Victor Chandra Bose, 1984), as in annexur - III.

The stocking density for grow out pens as recommended is 40,000 to 50,000 per hectare for *P. indicus* and 20,000 to 30,000 per hectare for *P. monodon*. The project has designed a unique seed collection net 'PUSH NET' which is more efficient, handy, and can be operated by a single person.

A formulated feed with squid effal (60%), Ground nut oil cake (10%), Rice bran (20%), Tapioca flour (7%) and Maida flour (3%) has been found to be more acceptable to the prawns in pens. The production has been reported to be ranging from 200-600 kg/ha/crop of 80 - 120 days with average production level of 400 – 500 kg/ha/crop of 100 days. Since the entire system is in large water bodies, survival has been reported to be 70% (Victor Chandra Bose, 1983). In this system utmost care is to be taken to mend the crab holes in the pen walls and remove pests and predators.

3.5. Hatchery development

Realising the difficulties in the collection of seeds from natural sources

and sorting, and transporting the Central Marine Fisheries Research Institution has established the first pilot scale prawn hatchery to produce quality seeds round the year at Narakkal in Kerala State during the year 1975 and almost all marine prawn species available in India had been succeessfully spawned and larve reared. Since then the institute extended their activities in Tamilnadu and established a prawn hatchery at Kovalam (Mohammed, 1983) and this is the first prawn hatchery of the state.

The Marine Products Export Development Authority has come forward to provied 50% of the capital investment or Rs. 3 lakhs for the establishment of a shrimp hatchery in the state. Utilising this financial assistance a pilot scale shrimp hatchery was established at Santhome in 1982 In the year 1982-83 spawners were procured from the trawl catches and used in the hatchery. Attempts were made to rear the larvae with algae, Brachionus and Artemia. Unconvential feed such as crustacean tissue suspension was also tried with partical success. From 1983-84 onwards spawner from catamaram catches are used Boiled egg yolk when tried as larval feed for all the larvel stages gave encouraging results with a survival of upto 20%.

3.6. Central organisations in the development of brackishwater farming.

The Central Research Organisations like Central Inland Fisheries Research Institute with two field Centres at Pulicat and Ennore in Chengleput District and the Central Marine Fisheries Research Institute with its Research Centres at Muttukkadu and Kovalam in Chengleput District and at Tuticorin, Mandapam in Tirunelveli and Ramnad District respectively are helping in conducting research on brackishwater fish farming, hatchery operation and coastal aquaculture.

3.6.1. Central Marine Fisheries Research Institute.

In the 90 acre water spread area of the Muthukkadu lagoon, a portion has been converted into brackishwater ponds and research programmes on farming of prawns, Mullets, Chanos are conducted. n the nearby mariculture laboratory at Kovalam, culture experiments on green mussel and lobsters are done. A prawn hatchery has also been established and are producing seed of *P. indicus* and *P. monodon* Tuticorin and Mandapam units are also involved in prawn culture research work.

3.6.2. Central Inland Fisheries Research Institute.

The research project of the centre include breeding and culture of prawns. At the Ennore hatchery of the Madras Research Centre, it has been shown that prawn larval rearing could be done into filtered brackishwater having a salinity range of 28-34%.

P. monodon and *P. indicus* were successfully bred at the hatchery and a spectacular success was achieved in the breeding of the former species by obtaining a survival rate of 48% from naupli to PL_1 without the use of Artemia nauplii.

3.7. Role of Private Sector.

3.7.1. M/s Tata Oil Mills, Co, LTD.,

Commensed a Research and Development project in an area of 10 hectares at

Thangal Perumpullam in Pulicat in 1980. Prawn Culture carried-out, at various stocking densities revealed the possibility of harvesting 1 to 1.5 tons of *P. indicus*/ ha/crop of 100 to 120 days.

3.7.2. M/s Show Wallace & Co.

The project commenced at Killai backwaters with 4 one acre ponds. After about two years of experimentation as they could not get additional land assigned in the area for further expansion because of Government policy they discontinued the project.

3.7.3. M/s Hindustan Levers Private Limited.

Established a shrimp hatchery at Muttukkadu near Kovalam in the year 1978-79. The present level of production capacity is around 3 lakhs of prawn seeds per month.

A successful project where the technology of induced maturation and land based production of spawners has been perfected.

4. Existing Government Policy and Support.

One of the objectives of the Sixth Five Year Plan is to popularise and launch coastal aquaculture projects with special preference to culture of prawns, brackishwater fishes, edible oysters, mussels, seaweeds etc. In the VI plan programme Government of India are making available as grant to the respective coastal states 50 % of the capital costs of setting up of prawn hatchery and developing 150 hectares brackishwater farms. A portion of the operating costs and cost on staff for encouraging the maritime states to intensify and expand activities of developing brackishwaters farming is given.

The state government have taken a policy decision that land suitable for brackishwater aquafarming should be exploited by government agencies or fishermen cooperatives only. The main object of this decision is to make available the brackishwater spreads of the state to coastal or rural population in order to enjoy the benefits of exploitation of brackishwater farms. This decision discourages the allotment of lands vested with government to private entrepreneurs, industrial units and companies. Therefore entire responsibility on the development of farm now vests with government agencies and co-operatives. The state government have recently decided to entrust the development of prawn farms and hatchery in Tamilnadu to Tamilnadu Fisheries Development Corporation and accordingly have directed the Tamilnadu Fisheries Development Corporation to develop prawn farms of over 150 hectares and for setting up of a prawn hatchery. The hatchery is to be established at Neelangarai in Madras with a production capacity of 16 million seeds.

Plans and estimates have also been prepared for the construction of a 50 hectare farm in Thondiakkadu. Under the Area Development Programme proposals have been sent to the government for developing 50 hectares of brackishwater farms at Punnakayal and another 50 ha. farm at T. V. S. Pettai and Pennanthittu at a cost of about 29 lakhs each.

5. Prospects for development.

In VII Five Year Plan, Under the Area Development programme with central assistance it has been proposed to develop 250 hectares at a cost of Rs. 250 lakhs. An additional hatchery has also been proposed at a cost of 20 lakhs. In addition to the above establishing two Brackishwater Fish Farmers Development Agency's for the coastal districts has also been stressed in the plan proposals.

The major constraint in the development of brackishwater fish farming in Tamilnadu is the non availability of suitable areas for big houses and entrepreneures.

Areas suitable for farming cannot be utilised by private entrepreneurs and companies who have got enough funds to utilise on construction of ponds and putting up of pumps which makes brackishwater farming a capital intensive scheme. The National Committee on the Development of backward areas in its report on "Development of coastal areas affected by salinity" (1981), in one of their recommendations regarding the policy to be followed by central and state governments for utilisation of the areas has suggested" that few areas of 100 to 200 hectares may be given out to large entrepreneures under very strict condition including utilisation of local labour"

Large farm should not depend upon seeds from natural resources as the seed resources are limited and seasonal. Moreover continuous intensive seed collection, if done, from nature will not only deplete the future capture fishery but also adversely affect the fishermen population who depend on the backwaters and lakes for their livelihood. Therefore seed production from the hatcheries is to be given priority. The repeated filtering of shallow areas for taking prawn seeds thereby upsetting the environment as well as destroying the other fauna and flora will deplete and upset the ecosystem in the long run.

The ban on any constuction within 500 meters from the highest water mark along the coast, is another constraint for developing hatcheries. Most suitable places along the coast should be identified demorcated and alloted to the government or private sector for setting up hatcheries as the area occupied by each hatchery will only be very small and huge structures will not come up and spoil the environment.

Brackishwater farming can be made more viable if the scheme is taken up as an Integrated Area Development Programme wherein all the basic infrastructure facilities like drinking water, transport, housing, electricity are provided. Further more insurance coverage against natural calamities like cyclone and floods is necessary.

Lack of proper knowledge in farm engineering may lead to failure of culture operations. The low tidal amplitude in the state poses problem in maintaining the wafter level in the ponds, which has to be taken into consideration while designing the construction. Therefore it is necessary to evolve suitable engineering skill to take effective steps to prevent seepage, design sluice gate to hold water during low and high tide

and minimise the pumping cosf and putting up of trenches in culture pond to hold minimum water level for better growth of prawns.

More studies are necessary to evolve the economic viability of brackishwater farms for suggesting the economic size of pond and to make the farmers aware of the facts pertaining to the investment return roatio to facilitate the adoption of the farm size based on their investment capacity.

Gap in the knowledge in the farming techniques may pose problem in the sound development of farming. The technical manpower requirement to train farmers (managers) will be an important need and has to be built by the state government and central institutions.

Because of high capital intensive nature, initial delay in getting returns and the small farmers are undercapitalised, the farmers may be hesitant to take up the venture. Therefore the government and the nationalised banks must come forward to advance loans and subsidies taking note of their organisational and management skill.

ANNEXURE — I

PERIODS OF SEED AVAILABILITY IN VARIOUS BACKWATERS (ANON 1979)

Sl. No. 1	District, Place 2	Prawns 3	Chanos 4	Mullet 5	Etroplus 6	Others 7
1.	Chingleput Dist. Pulicat, Kovalam Adayar	*Penaeus indicus* February, May, August, September *Penaeus monodon* March - May September - December *Penaeus semislucatus* February - May August - September	March - May	February - June	January-December	—
2.	South Arcot Dist. Kuzhuveli Vallar, Killai.	*Penaeus indicus* January - April June - September *Penaeus monodon* January. March, June *Penaeus semisulcatus* March - October	Fingerlings in small numbers year round	February - May	January-December	—
3.	Tanjore District, Thirumullaivasal Vettar, Thondiakadu.	*Penaeus indicus* January - April January - Septmber *Penaeus monodon* January, March, June *Penaeus semisulcatus* March - October.	April - May Small numbers year round	February - May small numbers year round.	Lates seeds in large numbers in Muthupet swamp	—

1	2	3	4	5	6	7
4.	Pudkkottai Dt. Kattumavadi Gopalapatnam, Minisal surf Collection from Palk bay	*Penaeus indicus* January - April January - September *Penaeus monodon* January, March, June *Penaeus semislucatus* March - October	Not available	Not available	No estuarine in Pudukkottai Dt.	—
5.	Ramanathapuram Dt Karangadu, Tiruppalakudy, Kannamunai, Athankarai, Pamban Chinnapalam	*Penaeus indicus* alround the year *Penaeus monodon* March to June *Penaeus semisulcatus* Not available	Millions of fry occur during April to June Fingerlings occur alround the year.	February-June	Alround the year	Pamban is an excellant source for Chanos and P. indicus seeds.
6.	Tirunelveli Dt. Punnakkayal, Pazhayalayal, Keelavanpar, Amalinayar	*Penaeus indicus* January - April June - September *Penaeus monodon* January - March - June *Penaeus semisulcatus* March - September - November	Small fingerlings, occur all round the year	March-July	Alround the year	Excellent collectionsfor *Penaeus semisulcatus*
7.	Kanyakumari Dt. (Manarkudy) Thengapattinam)	*Penaeus indicuse* January-April, June-September *Penaeus monodon &* *Penaeus semisulcatue* Not available.	-do-	February-June	Year round	—

ANNEXURE — II

SOME OF NOTABLE RESULTS OBTAINED FROM SANTHOME FISH FARM.

Year	Pond area	Species	Stocking rate/ha	Estimated production in kg/ha (%)
1976-77	0.1 ha	P. indicus	70,000	301.800 kg/ha/130 days
	0.1 ha	P. indicus C. Chanos	20,000 3,500	480.000 kg/ha/91 days 1140.000 kg/ha/180 days
1977-78	0.14 ha	P. monodon	20,000	514.700 kg/ha/80 days
	0.1 ha	P. indicus C. Chanos	37,000 6,000	1111.000 (704 + 407 kg in 2 crops)/150 days 1085,000 kgs.
1978-79	1.14 ha	P. monodon	25,000	440.300 kg/ha/90 days
1980-81	0.1	P. indicus	30,000	407.000 kg ha/120 days
1983-84	1.14 ha	P. indicus	70,000	682.450 kg/ha/110 days
1984-85	1.14 ha	P. indicus	30,000	360.000 kg/ha/60 days

ANNEXURE III

COST OF 0.5 HA PEN

The BOBP project on pen culture at Killai has estimated the cost of 0.5 ha pen (5000 sq.m.) as a unit manageable for family of 4 members.

Materials and rate	Quantity required	Amount Rs. Ps.
1. Knotless nylon webbing 10 mm (stretched) mesh Rs. 140/per kg.	50 kgs	7,000.00
2. Casuarina post 9-10 cms dia. at bottom and 3.5 mts high Rs. 375/per M. ton	1.5 ton	562.00
3. Casuarina cross bon 4-5 cms dia at bottom and 3-5 M length	100 nos	150.00
4. Foot Rope HDPE rope 6 mm dia Rs. 100/125 M	400 M	320.00
5. Coir rope 3-4 mm dia Rs.12/- per kg.	6 kg	72.00
6. HDPE rope 2 MM dia Rs.50/ per kg.	1 kg	50.00
7. Reinforcement webbing of HDPE 14 mm mesh (stretched) and 36 mesh depth Rs.60/-per kg..	21 kg	1,260.00
9. Labour charges for seaming reinforced layer at Rs.10/-per man day.	20 man days	200.00
8. Labour Charges for pen erection at Rs. 10/- per manday. 7 man days for 70 mts	30 man days	300.00
10. Metal turnover/spade-	1	50.00
		9,964.00
	or	10,000.00

ANNEXURE IV

CAPIAL COST FOR TEN 40 SQ. M. CAGES.

1. Cost of the cages at Rs 800/- cage for 10 cages	8,000.00
2. Equipments, Casuarina poles, Nylon ropes, Plastic Cowboys, sinkers	5,000.00
	13,000.00

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THE PRESENT STATUS OF PRAWN FARMING IN THE UNION TERRITORY OF PONDICHERRY

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The Union territory of Pondicherry (with four regions vis. Pondicherry, Karaikal, Mahe and Yanam) is a maritime state in view of its geographical location. It is naturally endowed with rivers, tributories, estuary and back waters and 800 hectares of brackish water isnow available with good and exportable varieties of shrimp. In view of this, there exist ample opportunities for taking up prawn farming on scientific lines to augment the shrimp production to meet the local and external marketing and export.

2. Prawn Farming exclusively to culture shrimp was not carried out either in the private or public sector in Pondicherry but in the Estuarine fish farms set up by Government in Pondicherry and Karaikal regions earlier during 1969 and 1974 respectively prawn was also grown along with the other varieties of estuarine fishes like mullet, chanos, etc., collecting prawn seeds from the estuary of Ariankuppam and Chunnambar of the Pondicherry region and Arasalar in the Karaikal region respectively.

3. But during the 6th Five Year Plan period a proposal was made to establish a shrimp experimental farm at Chinnaveerampattinam, Pondicherry region in the estuary of Chunnambar river. The Scientists from the Central Marine Fishery Research Institute, Cochin had visited this area and conducted preliminary survey to select the site for the above farm and suggested to Government to set up this farm at the present site. Subsequently the Director, Central Institute of Costal Engineering for Fishery, Bangalore, visited the area and prepared suitable plan and design to construct the shrimp experimental farm with an area of 4.90 hectares. The above farm will be taken up for construction soon at a total cost of Rs. 5.92 lakhs during this year. A total sum of Rs. 34.00 lakhs was set apart for this scheme of establishment of Brackish water shrimp experimental farm during the 7th Five Year Plan.

4. In the Brackish Water shrimp experimental farm, Chinnaveerampattinam Pondicherry, the shrimp farming activities will be carried out on experimental basis and the results will be made available to private aquaculturists to take up shrimp farming. Besides the farm will also be used for demonstration purposes to popularise among the pisciculturist to take up Brackish water fish farming in a big way. On seeing

the results and economics in shrimp farming similar farm will be proposed to be established all along the coastal belts either by the public or private sectors.

5. Under the Centrally Sponsored Scheme the scheme of the development of Brackish Water fish farming was also extended to this Union territory of Pondicherry by the Government of India. Under the above scheme, the Government of India is granting 100% subsidy for the capital expenditure towards conversion of Brackish waters; swamps etc., into shrimp farms, construction of hatchery etc., A total sum of Rs 10.00 lakhs was granted by the Government of India for this purpose.

6. The Director, Central Institute of Coastal Engineering for Fishery, Bangalore and Shri A. N. Ghosh, National Consultant inspected several sites and selected few sites at Karaikal region for the construction of shrimp farm. Accordingly a Brackish water shrimp farm at Karukalacherry, Karikal with an extent of 4 hectares will be established at a total cost of Rs. 2,92,000/-. Similarly another site at Kizhavely, Karaikal to an extent of 10 hectares was also selected to establish a shrimp farm. Necessary survey was already conducted by the Central Institute of Coastal Engineering for Fishery, Bangalore and the project report is being prepared with plan and design to take up construction work. Another site to an extent of 54 hectares was also selected at Keezhavanjoor, Karaikal to establish a shrimp farm. Necessary preliminary survey was already conducted and the results of the investigation are awaited to prepare plan end design for the shrimp farm.

7. The Scientist of the Marine Products Export Development Authority, Cochin had also visited Yanam region and conducted preliminary inspection, survey to establish similar shrimp farm under the Centrally Sponsored Scheme in the Iskitippah Island, Tanam region with an extent of 100 hectares. The project report is being under preparation. On receipt of the above report necessary action will be taken to establish shrimp farm at Yanam region also to increase shrimp product further.

8. Besides the above, a seperate scheme was also drawn up in the 7th Five Year Plan of this Union territory of Pondicherry viz. "Assistance to fish farm for the development of shrimp culture" to encourage the private aquaculturists to take up shrimp culture in a big way to fully utilise the marshy shallow area, back waters etc., for increasing the shrimp production for profit and export.

9. Under the above scheme it is proposed to grant 50% subsidy for the construction of shrimp farm, purchase of farm implements, prawn seeds etc. subject to a maximum of Rs. 10,000/- per hectare to each farmers. A total sum of Rs. 1.00 lakh has been provided under the budget of this Union territory of Pondicherry during the 7th Five Year plan period to benefit 10 numbers shrimp farmers.

10. The problem that confront shrimp culture in Pondicherry and Karaikal region is indicated below:-

Since Pondichery and Karaikal lies along the Coromandal coast where the sand drift in the sea along the coast is of high intensity due to wind and wave action the estuarine and back waters are closed most part of the year except for few months with the formation of sand bars thus preventing free entry of sea water devoid of tidal influence and prawn seeds throughout the year. Hence it requires suitable design of the prawn farms to maintain an economic lines in the present circumstances and assistance from Government in the form of subsidy atleast in the initial stages.

COASTAL AQUACULTURE POTENTIAL AND ITS PRESENT STATUS OF PRAWN FARMING IN ANDHRA PRADESH

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1. Introduction :

Coastal aquaculture is a promising area of development for increasing fish and prawn production. This was realised only a decade back when prawn production through capture fisheries and supply could not sustain the export demand. Other potential of prawn culture is utilising the derelict water for better aquatic harvest, in providing productive and remunerative employment, in improving the income of small farmers and overall development of the rural sector. The traditional fishermen utilised the sources to eke out their livelihood on part time besis but no attention was paid to the development of the brackish water fish culture till recently.

The rising demand and price structure in the international market for shrimp, the declining trend of prawn landings and also the hike in the cost of fuel in operating boats necessitated the stepping up of production of shrimp fishery in other suitable ways. Plentiful availability of species of fish and prawn of commercial value has attracted the minds of the entrepreneurs and the theme of development of shrimp and fish culture by utilizing the brackish water bodies has gained momentum.

Above 9.0 lakhs ha. of Brackish water culture area is estimated to exist in our Country. The major thrust suggested by the working group for formulation of VII Five Year Plan has recommended an increase in the area of Brackish Water Fish farming from 2,500 ha. to 10,000 ha.

An additional fish production of 0.15 lakhs tonnes apart from 0.40 lakh tonnes from Bheels and derelict canals is anticipated during VII Five Year Plan.

The working group has recommended Rs 60 crores to be allocated of which the central share would be Rs. 30.00 Crores.

2. Resources:

2.1. Water Resources:

Andhra Pradesh with a Coast line of 974 Kms. is the second largest maritime State in Indian Union. Rivers like Nagavali, Vamsadhara, Godavari, Krishna and Penna join the Bay of Bengal providing extensive Estuaries and back water resources. All along the

coast line there are numerous bays, low lying areas, estuaries, backwaters, brackish water lakes and man grave swamps. It is estimated that the brackish water areas including swamps available in Andhra Pradesh are 0.2 million hectares (vide report of Natioaal Commission of Agriculture) the vast brackish waters offer a natural source of exploitation of the Fishery which is influenced by ebb and tide.

2.2. Land Resources:

The survey conducted by the State indicated that there are 172 brackish water with a total water-spread area of 63,962.34 hectares covering 9 coastal districts of Andhra Pradesh. The district wise split up with ownership wise particulars are detailed below:

Sl. No.	District	Area ownership-wise						
		Fisheries Department	Revenue Department	Forest Department	Salt Department	Port Department	Private	Total
1.	Srikakulam	346.30	845.18	—	1,020.30	200.00	1,502.64	3,932.42
2.	Vijayanagaram	—	2.53	—	—	—	9.47	12.00
3.	Visakhapatnam	—	714.34	—	86.70	—	490.66	1,291.70
4.	East Godhavari	—	4,373.50	19,532.80	—	96.00	935.10	24,837.40
5.	West Godavari	—	1,583.00	—	—	—	1,884.50	3,467.50
6.	Krishna	—	16,418.57	8,000.00	—	—	243.42	24,661.99
7.	Guntur	—	254.16	1,310.00	—	—	30.64	1,594.80
8.	Prakasam	—	1,058.53	—	242.00	—	111.00	1,411.53
9.	Nellore	—	2,690.20	—	26.00	—	36.80	2,753.00
	TOTAL	346.30	27.940.01	28,842.80	1,384.00	296.00	5,243.83	61,532.34

Out of this the total area estimated as suitable for brackish water culture is 17,000 hectares excluding deep portions of swamps, creeks, drainage courses, thick mangrove forests and sand dunes, through developing and construction of brackish water farms. The areas belong to revenue, Salt, Forest Departments and private individuals.

This estimate, however, like all other estimates about brackishwater acquaculture is so macro that it can be totally misleading once a micro-level survey takes place and other relevent factors apart from the primafacie salinity factor at particular times are applied as suitability criteria for programatic and economic exploitation. This is the case I presume in all the States.

2.3 Timely and adequate supply of seed of the desired species is a pre-requisite for successful shrimp and fish farming.

The young ones of culturable varieties of prawn and fish are available all along the coast. About dozen species of prawn are available along the coast but generally collections are made in respect of P. monodon, P. indicus, M Nonocoros which are of commercial importance. The seeds of P. Monodon is available in plenty in the tidal creaks of Godavary and Krishna Districts where as P. Indicus is available along the entire coast line. The additional plentiful seed of chanos, mullets are also available in the State for Brackish water fish culture.

The peak seasons are observed to be June, August and October to December for shrimp seed and for milk fish the peak periods are April, July and November-December, while for mullets the peak is during October-February.

2.4 Man Power Resources:-

In Andra pradesh there are about 409 marine fishing villages along the coast having about 64,552 active fisherman. (Census survey of Central Marine Fisheries Research Institute, 1973-77). The total fishermen population who are directly dependent on these resourses is estimated to be 10,323. Appreciable advances have been made in the technology of prawn and fish culture in Brackish Water in recent years. Technology transfer however is as difficult or more so than technology acquisition.

The work carried out by brackish water fish farms of Central Institute of Fisheries Education and Andhra Pradesh Agricultural University, Kakinada and Bay of Bengal Programme at Polekurru are of Research and Development value as starting points. What a few select individuals have done on their private lands is quiet encouraging.

3. Government Policy for the Development of Brackish water:

In response to the suggestions made by the Ministry of Agriculture, Government of India to the various States that the State Government should take up massive programme for development of Fisheries especially with reference to identifying the brackish water potential for fish and prawn culture and followed by the indication of Sri V. Sivaraman, Member of Planning Commission to take up the Brackish Water fish culture in different

States under Centrally Sponsored Schemes during the VI plan period. The State Government have sanctioned a scheme for the survey of available brackish waters in the State and to identify suitable areas for development. Further the State Government have declared its land allotment policy for brackish water acquaculture also.

The Government of India have administratively cleared schemes for the development of Brackish Water farming in the State of Andra Pradesh from 1982-83 onwards with 50% of the cost as grant-in aid to the State Goverment, on the capital expenditure, incremental staff cost, training of Fish Farmers subsidy to fish farmers for inputs and other operational costs. The Government of India has further liberalised the policy according to which the capital cost on construction, development of common facilities such as approach roads, supply channels, feeder channels, bunds inlets and outlets sluice gates etc., will be borne by the Government The farmers will be trained before distribution of farm ponds to them.

3.2. Survey of Brackish Water area:

The Government of Andhra Pradesh have conducted a survey of all the brackish water areas available and the data pertaining to ownership, varieties of seed available, the area suitable for brackish water culture, craft and tackle operated in Brackish Water swamps, fishermen population, depending on the area, and available marketing practices. It is a broad survey if we are looking for data by which we can locate land for brackish water acquaculture on economically and technically feasible basis. Many relevant micro-level critical factors are missing from this first attempt at survey.

3.3. Land Policy:

An awareness has come among the people that brackish water fish culture if taken up on scientific lines will be a paying proposition. Many fishermen as well as educated unemployed persons belonging to middle class and lower middle class and many more big entrepreneurs have evinced keen interest in obtaining lands with brackish water sources on long lease for development of Brackish Water prawn culture. In view of this, the Government have laid down its the policy vide G.O.Ms No. 286, Forests and Rural Development (Fish. II) Department, dt. 11. 6. 80 for allotting the brackish water areas so that the areas that require low investment are to be allotted to weaker sections on priority and later to small self - employment entrepreneurs who are prepared to put in their own marginal money and lastly the areas of high investment to the bigger entrepreneurs. The policy has not yet become operational methodically though sporadic development of Government lands through D.R.D.A. and other such agencies for weaker sections has been taking place.

3.4. Macrolevel survey

To implement the Government orders to classify the sites depending upon the range of cost of construction etc. macrolevel survey was conducted for 3 days simulteneously in all the Coastal Districts during the month of September,

1980 and considerable data has been collected on various factors like accessibility, water supply system, water quality, soil quality, tidal fluctuation' vegetation and cost of construction etc. The data collected is found useful for broadly evaluating the sites for allotment. Microlevel survey has to be conducted for each site before actual construction of the farms is taken up, since macro-level survey has missed many a vital point.

3.5. Technical advice:

Through Food and Agricultural Organisation an Indonesian team had visited Andhra Pradesh to advise on the various aspects of farm engineering cultural practices and also to suggest establishment of a modern Brackish Water Fish Farm. Accordingly the 3 member T.C D.C. Mission (Indonesian Mission consisting of 1. Mr. Soleh Samsi, 2) Mr. Sihar Siregar and 3) Mr. Martone) visited brackish water areas of the State during 1981. The mission has suggested the strategy to take up large scale brackish water culture activity preceded by pilot schemes on the sites typical of various districts ecological areas particulary in respect of land elevation and tidal amplitude. The mission has further suggested two model ponds to suit the different areas of the State and suggested pen culture at select places.

Type 'A' pond:-

Investment Rs. 15,000 (including Pumping) polyculture of prawn and Milk Fish Rs. 2350 Monoculture of prawn (Rs 2600) and Milk Fish (Rs. 1700)

Type 'B' pond:

Investment Rs. 17,500 Operating cost of poly culture Rs. 2150 Monoculture of prawns and fish. 1500.

Mr. Jamendre, a hatchery specialist from Philippines was also brought by Marine Products Export Development Authority to the State during Feb, 1981 to study the possibilities for developing prawn hatcheries in the State.

Mr. Padlan, Aquaculturist, Mr. J. Kovari, Aquaculture Engineer from Philippines have vlsited the State during May, 1981. The team has recommended investment designs for indicating institutional Finance and Engineering drawing etc.,

Aquaculture engineering team from Indian Institute of Technology, Khargpur also visited the State during December, 1981 and given detailed remarks on the construction cost of the ponds with reference to the estimated and types of ponds suggested by T.C.D.C. Mission.

To expedite the development of coastal aquaculture and to render technical assistance in the field of Coastal aquaculture Engineering, the government of India has reoriented and redesignated the existing fishing harbour survey unit located at Bangalore as "Central Institute of Coastal Engineering for Fishery" having purview over costal aquaculture and fishing harbours. The Director and his technical staff have visited the state several times, and assisted in preparation of estimates and designes of Brackish Water fish farm at Polekeru apart from

giving training to State Engineers and conducting evaluation study as well.

4. Development of Brackish Water Fish Farms in Andhra Pradesh

4.1 Development of Brackish Water Farms under Public Sector :-

Even in early 1940 when Andhra Pradesh was part of the erstwhile Madras State, although the Department of Fisheries had not taken up culture of fisheries in brackish water, considerable attention was paid to collecting fry of chanos on large scale from the brackish waters to culture them in fresh water after acclimatisation. The activity was continued till late 1980.

Government of Andhra Pradesh established in early 1960 a brackish water fish farm at Kakinada by reclaiming swamps area and subsequently handed it over to Central Institute of Fisheries Education, Bombay. It is a tide fed farm. The esults obtained at this farm are quite encouraging.

The Institute is presently offering training on managment of Fish Farms, shrimp hatcheries and culture of feed.

The Indian Council of Agricultural Research established a brackish water fish culture experimental farm at Kakinada as one of the all India Coordinated Research Project. The project was subseqently transferred to Andhra Pradesh Agricultural University. The experiments under Mono and Polyculture conducted by the Institute have yielded encouraging results.

The Andhra Pradesh Fisheries Corporation Limited, Kakinada established a brackish water fish farm at Kakinada on 76 hectares with a water spread area of 45 hectares at a cost of Rs. 15.00 lakhs under Centrally Sponsored Scheme during 1980-81. The Farm was intended to serve as pilot project for brackish water culture in the State but the problems of technology transfer dispute abundant reports, studies and researches have landed the farm and the corporation in the red as obviously some elementry factors like tidal amplitude were ignored resulting a farm with higher salinity than the sea breeding nought but milk fish. It stands as the first milestone on over technological road that begins and ends at that milestone. So fresh roads have been laid with similar results till very recently. In the process, not only did we burn our fingers but such precious millions of rupees of Government and institutional finance.

A brackish water fish farm in 5 hectares area with 2.93 hectares wter spread areas was established at Tallapalema in Krishna District by Marine Products Export Development Authority to serve as Demonstration-cum-Training in State in Brackish Water Fish culture.

Brackish Water project in an extent of 230 hectares with a water spread area of 155 hectares was established during 1982-83 for the benefit of 207 beneficiaries belonging to sheduled caste and Backward classes at Vemuldeevi in West Godavari District, with no better results than the Kakinada farm.

This project was also intended to

create full time employment to 207 beneficiaries belonging to scheduled Castes and Backward Classes. The total cost of the project is Rs. 75.00 lakhs. At Vemuravalli in Srikakulam District, Anveshana schemes in Krishna District and Gurralanka Parra in Guntur District, fortunately turned out to be early abortions with little lost on them.

4.2. Shrimp Culture Pilot Project, Polekkurru East Godavari District (Bay of Bengal Programme)

The main object of this farm is to find out a suitable pond design and sluice design culture practices and appropriate water management for pond culture of shrimp in a representative area in Andhra Pradesh. The District Collector, East Godavari District allotted 15 hectares of land for this purposes.

The construction of the farm started in mid December, 1982 and was completed by 2nd week of August, 1983. In April, 1984 some additional construction work was done. The farm consists of six ponds (0.6 to 0.75 ha) a 5 meter wide feeding-cum-drainage canal, a seperate narrow drainage canal for pond 1, a two vent main sluice gate at the entrance to the feeding canal, five masonary sluice and six wooden sluices including one outlet.

All the ponds are rectangular in shape and each approximately 125×60 meters in Size. Four Ponds are tide fed and two ponds are partially tied fed and partially pump fed. The expenditure incurred for construction of this farm is as detailed below:-

		Rs. Ps.
1. Earth excavation	—	1,09,904.68
2. Main sluice gate	—	41,877.42
3. 5 Mansonary sluices	—	44,740.00
4. 6 Wooden sluices	—	32,054.00
Total	—	2,28,576.10

Culture of Shrimp

The ponds are stocked with *Penaeus, monodon, P. indicus* results of ponds are presented.

Pond. No.	Qty. of *P. monodon* harvested. (Kgs)	Qty. of *P indicus* harvested (Kgs)	Other Misc. harvested (Kgs)	Total production (Kgs)
1.	47.8	89.7	63.3	200.8
2.	265.3	—	43.3	308,6
3.	213.0	—	90.6	303.6
4.	170.0	—	25.7	195.3
5.	1.7	105.0	79.6	186.4
6.	147.6	16.5	16.5	180.6

Biological Information :

Culturable shrimp (*Penaeus monodon & P. indicus*) is available in and around Polekurru island throughout the year; peak season of seed availability is July-December.

Liza Sp. and *Mugil* species seeds are available. Among the predatory fishes usually found in this island waters are *Lates calcarifer, polynhmus indicus Megalops Sp.* and other cat fishes.

Brackish Water Plankters available the near project consists prominently of Diatoms, Desmids and Flagellates, Copepods, Rotifers and a few larvel forms too represent planktonic collections.

Sea otters, Wild cats, Foxes and various birds represent the competitors.

D.R.D.A. Farm :

Under D.R.D.A. in East Godavari District, Collector has taken up a brackish water fish farm in Polekurru.

Centrally Sponsored Scheme :

About 75 ha. of Centrally Sponsored fish farm are being constructed in Polekurru East Godavari District at a coast of approximate 27 lakhs under designs provided by Central Institute of Coastal Engineering for Fishery Bangalore. The local engineers feel the amount is misearbly insufficient.

4.3. Under Private Sector:-

Encouraged by the results obtained in the different fish farms managed by the different institutes under public sector undertakings and also convinced by the training imparted by the institutions 43 entrepreneurs have taken up Brackish Water Fish Farming covering an area of 137.8 hectares with 117.4 hectares water spread. The estimated cost of investment comes to Rs. 31,094 lakhs. Some of the important Farms established are detailed below:-

Sl. No.	Name of the Entrepreneurs/ Farm	Total area Converted in Hect.	No. of Ponds	Investment in lakhs	Water supply by tide fed or pump fed
Visakhapatnam:					
1.	Ch. Mason	6 0	3	1.27	—
2.	M/s. Solar Salts	10.0	4	4.00	—
3.	B.C. Trust	4.37	8	0 73	This is failu re
West Godavari Dist.:					
1.	Damisetty Sathiaraju	32.0	14	6.50	Pump fed Partially
2.	P. Ranga Rao & Others	8.00	20	4.46	—
3.	Swarna Fishery Complex	7.2	6	—	Saline Soil with fresh water
Prakasam:					
1.	EFFICOR	1.2	2	0.50	—

A small 5 hectares Farm in Srikakulam District and another small 5 hectares Farm in East Godavari District are also a testimony to success of small entreprenuers personally among Brackish Water acqua-culture.

A farm is established at Karpa in East Godavari District in 18 acres land with a view to utilise the saline soils to culture prawn with fresh water. The results are found to achieve higher income than agriculture.

The results obtained in some of the farms undertaken by private entrepreneurs are encouraging, as may be expected.

4. 3. Culture Practices :-

The culture of Brackish Water Fish and Prawn is being undertaken in the farms already established in Andhra Pradesh both under public and private sector. Both Poly and Mono-culture of fish and prawn have been attempted with varying degrees of success and failure. The first two attempts have been miserable failures and have become thus the pillars of subsequent successes.

The Farm of Central Institute of Fisheries Education at Kakinada produced 1337.5 of prawn and 3000 Kgs. of fish per hectare per year.

The Farm of Andhra Pradesh Agricultural University, Kakinada produced 430 Kgs./hectares of *P. monodon* in two crops in a year under Mono-culture practices. The Polyculture was also undertaken with Mullets, Chanos and Prawn. One private entrepreneur at Kakinada under the guidence of the Andhra Pradesh Agricultural University has attained a production of 1340 Kgs. of Chanos and 216 Kg. of Prawn per hectare in 5 months period. M/s. Solar Salts with the collabration of Union Carbide India Limited has achieved a production of 416 Kgs./hect. in one crop. Whereas Ch.Mason has achieved 1500 Kgs. fish production per hectare besides this the salt reservoirs under the Salt Cooperative Society have also been cultured but the results are not so encouraging, but the cost of culture is found to be cheeper. Yet Prawn in most of these farms except Bay of Bengal Programme Farm seems less in evidence than fish. In fact the Bay of Bengal Programme results so far can not be said to be anywhere near the normal productivity expected of a luxuriously nursed farm. Obviously technology is still in the process of being developed by us and we are slow in absorbing technology transfer.

5. Brackish Water culture during VII Five Year Plan :

An amount of Rs. 27 lakhs is provided in VII Five Year Plan for the development of Brackish Water areas in the State. If we get Centrally Sponsored Schemes we can get more amount.

Our District level Schemes :

The financial allocations during VII Five Year Plan areas (1) Specialised Fish Farmers Development Agencies (7 Nos.) Rs. 270.00 + 182.60 = Rs.432.60. lakhs

(2) Establishment of prawn hetcheries Rs.40.00 + Rs. 40.00 = Rs. 80.00: Total (ITEM) (1 + 2) Rs 532.60 lakhs.

6. Constraints in developing Brackish Water :

6.1. Tidal Regime :

The most important consideration is the selection of the site in relation to the tidal amplitude at the site. It is preferred that the ground elevation between mean high tide and mean low tide should be such that it should be possible to maintain water depth of 0.7 m. in the ponds and to fill and empty the ponds utilising the tidal rise and fall alone. To get this ideally the tidal amplitude at the site should be around 1.2 m. and the pond bottom should be a little above the mean low water near tide level, so that the pond could be drained completely at any low

tide and could be filled with water if necessary at every high tide.

The tidal amplitude of the State varies 0.8 to 1.6 m. for most of the sites. In the Northern part of the State due to elevation of the land at many places the tidal range is not sufficient at the site for the construction of the tidal forms. Therefore care has to be taken for selecting the sites keeping in view of the tidal amplitude and elevation of the site. The economics and viability of pumping have yet to be proved through a combination of pumping and dependence on tidal amplitude seem to be inevitable and perhaps quite viable also.

6.2. Seed :-

Andhra Pradesh is rich in cultivable species of prawn and fish which are suitable for Brackish Water culture. Among them *P. monodon*, *P. indicus*, and *M. monocros* are commonly available in the tidal creeks and estuaries. Among fish mullets and Chanos are available in most of the areas all along the Coast but they fetch such low price that we need not count them.

All are under loss. If 1/10th of the available area is brought under the culture it is estimated that seed available from natural sources may not be sufficient. Studies have been commenced very recently to gather data on occurance of culturable varieties with qualitative and quantitative analysis whenever possible. But it will be a along time before 1/10th of the identifiable area is brought under Shrimp culture. So in the Seed Front there is really no cause for anxiety and hatcheries are not a pressing present need but conservation ef juveniles is more important. It is good, however to have atleast one or two good commercial level hatcheries to begin with, in this State.

6.3. Site Selection :

Selection of a site is basis and vital point for the successfull functioning of Brackish Water Farm. While selecting the site land elevation, accessibility, tidal range etc. are to be considered.

4. Soil Engineering :-

Brackish Water farming is quite different from fresh water farming. Most of the site situated at the flood discharge point where sudden and heavy gush of water flow is anticipated speacial engineering techniques are developed various institutions to construct the same. Therefore qualified Soil Engineering techniques have to be adopted in the design and establishment of the farms.

6.5. Design and layout :

Qualified personnel is a big constraint.

6.6 Preparation of economic viability Reports :-

Brackish Water farming is of Capital-intensive oriented scheme. Institutional finance needs Project Reports.

6.7 Training :-

Brackish Water Farming needs operation by persons having inter-disciplanary technical knowledge. Training facilities have to be increased in a large scale.

6.8 Financing and Managment :-

Establishment of Brackish Water Farming needs provision of timely and purposeful financial assistance. Further

the maintenance of the Brackish water Farming involves so many problems such as water managment, procurement of seed, feeding, harvesting and marketing. The entrepreneurs are at present in need of constant coordination and guidance in these aspects.

All the above aspects need magnetic institutions and competent support at this stage of development. Only well-managed Fish Farmers Development Agencies can do this. That really means a lot of trained man power paid consultaneous can also help.

7. Suggestions, Recommendation to Marine Products Export Development Authority (MPEDA) development of Brackish Water farming

1. MPEDA could come in a big way for providing coordinating the area development programmes.

2. MPEDA could provide subsidy on feed and also Research and Development on suitable feed component, designs etc.

3. In Andhra Pradesh all the Brackish Water areas are suitable for culture and mostly depend upon pumping of water and very rarely are tidal fed. So MPEDA could come forward to supply pump sets and motors on subsidy basis.

4. The MPEDA could finance for Research and Development.

5. As the tidal amplitude is very low at brackish water sites farm engineering techniques have to be evolved to minimise the capital outlay on pond formation as this directly relates to the viablity of Brackish Water farming. Any mistake in the pond design and construction not only results in extra capital cost, but also involves recurring expenses which affects economy of farm management.

OUR BRACKISH WATER POLICY PERCEPTION:

We would like our Brackish Water Aquaculture Policy to be as under :

I. Learning from costly mistakes, we have come to believe strongly that unless there is a thorough microlevel survey of any site, we shall not consider it as a Brackish Water Aquaculture source worth exploitation.

II. We would like to decide on allotment of Government lands for Brackish Water Aquaculture only after we have got identified areas micro-surrveyed and have a clear total picture. Marine Products Export Development Authority (MPEDA) proves the point that most of the identified lands are not suitable for Brackish Water Aquaculture economically. We do hope these conclusions are tentative. If not they dampen all spirits. If extrapolated we might stop talking of Brackish water Aquaculture completely. But, I believe, this micro-level survey is after all partly impressionistic and not too micro in any case. I may be pardoned for this observations.

III. We would like to have a separate development plan for 5,000 odd hectares of Brackish Water swamps which are included in our total identified areas, as fishermen families already live by

catch in these swamps Whether PEN culture, Cage Culture or pond culture suits their development has to be first decided with proper expert advice. These areas are no doubt the best for prawn culture. We invite Marine Products Export Development Authority to step in to obtain for us technical and finances for their development. They will find themselves amply rewarded in terms of returns in foreign exchange as well as in terms of profits.

IV. We would like to have more areas under Centrally Sponsored and jointly with MPEDA or State Trading Corporation, Brackish Water Fish Farm. We have on hand only designs and estimates for 50 more hectares for Centrelly Sponsored Scheme in Polekurru (East Godavari District). Areas surveyed in a part of Gilakaladindi in Krishna District by Central Institute of Coastal Engineering for Fishery, Bangalore have been rejected by them. But there is no doubt that there are alternative large areas in Gilakaldindi available for them to select.

V. We believe that the frugal rate of Rs. 49,000/- per hectare fixed by Government of India for construction of Brackish Water Farm is only penny-wise. Our estimates indicate Rs. 80,000/- per hectare to be more realistic.

VI. We believe that unless we boldly introduce PEN culture in most of our areas, we would be missing the best of our brackish waters Farm prawn culture.

VII. We welcome entrepreneurs whose basic qualification is expertise in this field of aquaculture not necesaarily financial wizards. Those who can bring to us technology of brackish Water Aquaculture, the lateset and the best, from Cochin to U. S. A. We shall give him land and all that he needs and as the saying goes "All this and Heaven Too". To the rest of entreprenuers who are therein everything from cosmetics to killer gases and smell new prospects everywhere, we say, no land for your income tax common flages, but show us your expertise.

VIII. We believe that those who can afford it should go in for Brackish Water culture in private areas of which there are plenty.

IX. We invite technical consultancy services on Brackish Water prawn farming from micro-level survey and selection of sites to designs and setting up and running of farms. These can be paid services.

X. We feel that MPEDA and Government of India and all those interested in hard currencies like Yen, US Dollars, Oil dollers and EEC currencies, must whole-heartedly develop and make available :--

1. Technology
2. Finances
3. Human resource needed training and other development through facilities on a large scale,
4. Research and Development, and
5. Market development.

XI. We feel that the primorial task is to complete a micro-level survey with designs and estimates and feasibility

reports on all the identified lands with the Government and take up similar work for private lands on consultancy basis. Otherwise we will be limping along behind a racing world.

XII. We would like to touch our mangrove forests last and only if inevitable.

XIII. We feel that a time has come to have an aggressive marketing policy for shrimp that will give a fillup to higher levels of investment for Brackish Water aquaculture. Our supplicant dependence on Japan has to end.

XIV. We feel that the unearned income brought in by chartering of vessels should be linked up with pen culture and heavy investment aquaculture with most difficult technology in prawn rich brackish water. That should be a condition of charter. The two cannot and should not be divorced.

XV. We feel that fisher folk should be brought into Brackish Water Aquaculture in a big way through cross subsidisation or compulsory partnership with entrepreneure seeking Government lands for brackish water culture.

XVI. We also feel that a balance between salt production and brackish water aquaculture has to be found where lands under salt manufacture selected.

XVII. We believe that we can go in for prawn hatcheries. But these should be simple and economic and we should have enough farms to absorb the seed. We should first take steps for conservation of juveniles indiscriminately being destroyed.

XVIII. In short, after the initial euphoria and hustling, the time has come to look at things more rationally and this rationality is a highly loaded concept-it involves economics, appropriate technology, balancing of various interests and view points, economic trade offs, ecological considerations and above all market development to make heavy investment possible is must.

XIX. We feel that where should be special Brackish Water fish Farmers Development Agencies, manned by well-trained people in different disciplines required for the purpose and such agencies should be under centrally sponsored schemes like the other Fish Farmers Development Agencies. This alone can achieve any progress in this field.

XX. And lastly, I may submit what is prior even to the primor dial, the development of infrastructure specially roads, bridges, electification, communications, ferry launches, protected water supply, public transport system and of course housing and schools, shopping facilities for people to open out inaccessible highly potencial Brackish Water prawn culture areas.

The location of Estuarine areas specially private lands is so inaccessible

that the cost of development and maintenance and management of brackish water aquaculture for prawn is astromonically uneconomic and prohibitive. Essentially, therefore brackish water aquaculture and its foreign exchange and potential boils down to area development programmes in estuarine areas. Integrated policy making is difficult, but if it can be done, we can open up vast areas of Konaseema in East Godavari District, Pulicat Lake in Nellore and many such areas in West Godavari and areas like Gilakaldindi etc. in Krishna District to unlimited prawn wealth for the generations to come.

It means a great deal of coordination between MPEDA, Ministry of Commerce and Agriculture and Rural Development of Government of India and the State Governments, and of course Planning Commission and Finance.

ANDHRA PRADESH

ACTION PLAN FOR PRAWN FARMING DURING 7TH FIVE YEAR PLAN

1. Construction of Brackish Water Fish Ponds at Polekurru Phase. 1. Rs. 26.747 lakhs.

Government of India in their letter No. 31035-9/82 FY (T.1), dt. 5.12.83 have conveyed their administrative approval for construction of fish pond in Brackish Water area at Polekurru at an estimated cost of Rs. 25,11,600/- under Centrally sponsored scheme during VI Five Year Plan. This amount of Rs. 25,11,600/- will shared by Govt. of India and Government of Andhra Pradesh on 50:50 basis. Govt. of India have also released an amount of Rs. 7.00 lakhs during the year 1982-83 on adhoc basis in their letter No. 31038-47/80-FY(T. I), dt. 5. 11;82.

The civil work has been entrusted to the executive Engineer (R&B) Kakinada and the amount already released by Govt of India was kept at the disposal of the Executive Engineer (R&B) Kakinada. The Executive Engineer (R&B) has prepared the revised estimates after discussing the matter with the Director, Central institute of Coastal Engineering for Fishery (CICEF) Banglore for Rs. 28.489 lakhs which was approved for Rs. 26.747 lakhs by the Director, CICEF, Banglore.

During the year 1984-85 the Executive Engineer (R&B) has incurred an expenditure of Rs. 7.00 lakhs upto end of March. 85. So far the earth work for 7 ponds has been completed except the consolidation of bunds and the work for another 6 ponds including (2) reservoirs are in progress.

The construction of remaining 39 ponds will be taken up in the VII Five Year Plan. Government have also addressed for release of balance amounts towards their share as detailed below:

Cost of project.	Govt. of A. P. Share.	G. O. I. Share.
Rs. 26.747 lakhs.	Rs. 13,37,350/-	Rs. 13,37,350/-
Amounts released.	-	Rs. 7,00.000/-
	Rs. 13,37,350/-	Rs. 6,37,350/-
Balance amount yet to be released.		

On releasing the amounts by Govt. of Andhra Pradesh and Govt. of India the project will be completed in the VII Five Year Plan. As per the project report proposed by the Director, CICEF, covers only 54.55 hectares water spread area. The additional prawn and fish production is expected to 33.00 tonnes and 55.00 tonnes respectively per year.

II. Construction of Brackish Water fish farming at Polekurru Phase. II. Rs. 12.60 lakhs.

Govt of India have furnished a copy of the technical report prepared by the Director, CICEF, for construction of 28 number ponds in water spread area of 25.2 ha. at total cost of Rs. 12.60 lakhs under Centrally Sponsored Scheme. A copy of the report has already been supplied to the Jt. Director of Fisheries (BW) Kakinada with instruction to contact the Executive Engineer (R&B) personally and to obtain the revised estimates as per the present schedule of rates. On receipt of the revised estimates the same my be submitted to Govt. of Andhra Pradesh for obtaining the administrative approval of Govt. of India and to takeup in 7th Five Year Plan. Proposals for the sanction of the scheme were submitted to Govt. of Andhra Pradesh with the copy of the report under this office Lr. No, 8956/ dl. 85 dt. 28.4,95

The anticipated prawn and fish production will be about 15.00 tonnes and 25.00 tonnes respectively per year.

III. Establishment of 7 Marine Fish Farmers Development Agencies in the Coastal Districts of Andhra Pradesh Rs. 91.00 lakhs.

The State has got vast resources of Marine and brackish water areas etc. along the coast line of 974 Kms. The culture fisheries in these is still evergreen potential resources which can be exploited under modern cultural techniques of Brackish Water ponds/pen/mericulture. These cultural methods are technically sound, economically viable and the product has established national and International market demand. The Brackish water development is now national resources of rural economic upliftment and generating employment opportunities. To achieve these objectives it is proposed to set up seven special marine Fish Farmers Development Agencies in the coastal Districts of Andhra Pradesh with similar Fish Farmers Development Agencies for Inland fish culture under Centrally sponsores scheme during the 7th Five Year Plan.

During the year 1985-86 it is proposed to set up a Fish Farmers Development Agency in East Godavari District with District Collector as Chairman and Managing Committee on similar lines of inland Fish Farmers Development Agencies (FFDAs) It will (1) undertake Brackish Water pond culture in the area of 50 ha./P. A. Development under Brackish Water scheme (2) undertake Brackish Water pen culture in swamps in an area of 50 ha/PA. The agency will have the principal objective of coordinated culture operations under technical

supervision for enhanced productivity of nutritative food for generating rural employment oportunities.

Financial implications for each Fish Farmers Development Agency

1.	Subsidy on inputs.	11.00 1akhs
2.	Management charges	2.00 lakhs.
	Total	13.00 lakhs

The Govt of India will share 50% of 11.00 lakhs is 5 50 lakhe as Govt, of Andhra Pradesh will share 50% of 11.00 lakhs and 2.00 lakhs towards management charges. Thus the total 7.50 lakhs has to borne by Andhra Pradesh Government. The total beneficiaries will be 100 members and the production will be 30 tonnes in each Fish Farmers Development Agency per year.

IV. Establishment of Prawn Hatchery in Andhra Pradesh Total Project Rs. 80.00 lakhs

It is proposed to setup prawn hatchery in the coastal Districts at a total cost of Rs. 80.00 lakhs under Centrally Sponsored Scheme during VII Five Year Plan. One of marine prawn hatchery will be setup in East Godavarj District at a cost of Rs. 40.00 laks during the year 1985.86.

We are expecting one from Marine Products Export Development Authority also.

The hatchery can provide 200 laks prawn post larve in first year and can be stepped up to 400 laks in due course.

V. Improvement to the Brackish Water Fish Farm at Vemuladeevi Rs. 15.95 lakhs.

The Brackish Water Fish Farm is situtate near Vemuladeevi village in Narsapur Taluk of West Godavari District. This farm consists of 207 ponds vary in area from 0.36 hectares to 1.58 hectares. The total water spread area is 175 hectares. The total expenditure incurred by the Govt. cf Andhra Pradesh as on construction of ponds for Rs. 65.00 lakhs. The Director Central Institute for Coastal Engineering for Fishery, Banglore has proposed an additional amount of Rs. 15.95 lakhs to put the farm into operation. Thus the total expenditure on the construction of the farm will be Rs. 80.95 lakhs working out Rs. 46,257.00 per hectare.

The total operating cost one hectare unit comes to Rs. 14,500.00

The additional prawn Fish productlon will be 105.00 tonnes and 175.00 tonnes respectively per year from the total water spread area of 175.00 hectares.

Sd. J. M. Girglani,
Director of Fisheries

PRESENT STATUS OF PRAWN FARMING IN ORISSA

B DAS [1] & S K MOHANTY [2]

Department of Fisheries Orissa, Cuttack - 753007

1. Introduction :

Brackishwater Prawn Farming in India is vitally important not only for very high unit value of prawns but also for improving rural economy, and for providing gainful employment to a larger section of rural population where about 80% of the population live below the poverty line. Above 1.70 million ha of potential brackishwater are exist in our country and hardly 30,000 ha. (5000 ha. in Kerala; 5000 ha. in Karnataka and 20,000 ha. in West Bengal) are being used for culturing marine prawns in traditional methods. The average unit price realised is also much low due to mixed composition of prawns and non uniform size. By adopting semi-intensive culture method, the average yield can be increased to a modest rate of 500 kg/ha./year valued at Rs. 25,000. Assuming at least 50% development of the total available resources for prawn farming in future and taking a very conservative estimate of the yield of 225 kg/ha. the annual production from cultivation comes to nearly 0.19 million tonnes of prawns which is more than the present total landings of the country.

1.1 : The State of Orissa is endowed with vast area of estuaries, lakes/lagoons, tidal flats, mangrove swamps, creeks, salt marshes and salt pans which together cover an estimated area of 0.299 million hectares, The presently available resources that can be developed into brackishwater farms is estimated at 31,618 ha. excluding lake, estuaries, creeks, etc.

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1. Deputy Director of Fisheries, (SBW), Cuttack, Jodra Nuasahi, Cuttack - 3
2. Chief Executive Officer, Brackishwater Fisheries Development Agency, (Puri-Ganjam), Puri 752 001

By virtue of the geographical location of the State, the amplitude of the diurnal tidal cycles range between 1 - 2 m which is quite favourable for water management of the type of brackishwater culture technology followed in our country.

The general clayee soil base of the entire coast line of 480 km. long except for a limited stretch in southern part and the presence of numerous tidal creeks and swamps support by a mangrove belt in the northern and mid-coastal line and the large Chilka lake and Rushikulya-Bahuda estuaries in the southern part largely favour the brackishwater enviornment for natural seed availability and prawn farming Considering the aspect

of ecological balance and protection of natural nursery area for prawns and fin fish, if the mangrove belt of the north-central portion of the coast line is left undisturbed, a total of about 17,000 ha. of brackishwater area can be suitably developed into prawn farming projects yielding about 4250 tonnes of prawn annually at a conservative estimate of 250 kg/ha which is almost equal to the present total prawn landings of the State. Besides, several thousand tonnes of fin fish can also be produced. If 75% of the brackishwater are under the control of Revenue Department is leased out to the weaker section of the society in addition to the area under private ownership, about 65000 poor families in the remote coastal area including the Chilka area can be economically rehabilitated through prawn farming. Besides, about 62000 poor famllies can be benefitted by seed collection and supply of inputs and impliments.

2. BrackishWater Resources of Orissa:

2.1. Available Brackishwater Area for Development:

In Orissa, the extent of brackish-water area available within four major estuaries and Chilka Lake spreading over four coastal districts has been estimated at 31,618 ha. belonging to various Govt. Deppts., and private ownership. The extent of suitable brackishwater area that can be developed into productive coastal aquaculture projects is estimated to be 20300 ha. excluding the dense mangrove forests with a net- work of numerous tidal creeks within the Bramhani-Baitarani and Mahanadi estuarine reaches. From the resources inventory survey undertaken by the department of fisheries since 1979-80, low lying brackishwater area without mangrove forest growth which can be considered as comparatively more suitable area for development of prawn farming has been estimated to be 17000 ha. The district-wise area and ownership of brackishwater resources are given below :

Table—1

Available area and ownership of brackishwater resources in Orissa*:

District	Area by ownership (ha)						
	Fisheries Dept.	Revenue Dept.	Forest Dept.	Salt & Excise Dept.	Port	Private	Total
Balasore	15	2620	250	160	-	750	3795
Cuttack	10	5350	11050	-	250	900	17560
Puri	9	5327	-	160	-	1153	6649
Ganjam	20	2024	-	1416	-	154	3614
	54	15321	11300	1736	250	2957	31618

*Includes land submerged by the higest tide ,but excludes the summer water spread area of the Chilka Lake, Estuaries, creeks and lagoons.

Of the above available brackish-water area, the brackishwater survey wing of the Department of Fisheries, Government of Orissa and the recently set up Brackish Water Fisheries Development Agencies have conducted detailed survey and identified 15,333 ha. of suitable brackishwater area till March, 1985 for development of prawn farming in four coastal districts.

In Chilka lake alone, about 5005.79 ha of area have so far been identified which works out to 32.64% of total suitable area identified. The survey of identifying the suitable area in the State, is still in progress and more of suitable area are expected to be identified in next 2-3 years when a complete master plan can be prepared for development of prawn farming in the State. The so far identification position of suitable brackishwater area is as under :

Table—II

Identified brackishwater area suitable for development (progress as on 31-3-1985)

District	Area Surveyed (ha.)	Area found suitable (ha)
Balasore	3484.74	2820.10
Cuttack	6695.99	5699.81
Puri	5331.70	4782.90
Ganjam	2470.75	2030.75
Total	17,983,3.18	15,333.56

2.2 Soil Type

The costal belt of the northern part embracing the estuaries of Subarnarekha, Budhabalanga, Baitrani-Bramhani rivers and Mohanadi deltaic complex of the mid-coastal line are characterised by inter-tidal clayee soil. In the area between the mouth of Mohanadi and Devi rivers and the peripheral flats of the Chilka lake the clayee soil is more firm and impervious which offers better advantages for pond excavation and construction of dykes. The southern coast line between Rushikulya and Bahuda estuaries has a sandy-clay soil.

2.3 Seed Resources

The State Fisheries Department initiated seed prospecting survey in all the potential estuaries by establishing ten numbers of regular seed collection centres in the year 1979 / 80 which continued till 1982-83. Systematic data have been collected during these four years

continuous survey which reveals that the seed potential of important species of culturable prawns, mainly, *Penaeus monodon* and *Penaeus indicus* is 130 million, of which *P. monodon* and *P. indicus* are available through out the year with their period of abundance during March to June and November to February. The season of abundance for *P. monodon* is from April to June and from November to February. The abundance of *P. indicus* has been recorded during March to July and November to January. Seeds of Metapenaeids are available in all the estuaries and backwaters along Orissa coast. They constitute nearly 23-30% but they are dominant varying from 60-80% during the period when the post larvae of *P. monodon* and *P. indicus* are not conspicious. Another survey was conducted during 1983-84 and 1984-85 to assess the availability of juveniles (30-60mm) in different estuaries and the Chilka Lake. The recent survey indicated that creek net work at Jatadhar in Mohanadi estuary, Rushikulya estuary, coast canal near Budhabalanga estuary and Chilka lake including Palur canal are potential sources for collection of prawn juveniles of 30-60 mm size. The Chilka lagoon is perhaps one of the richest brackishwater capture fisheries and nursaries of the country which offers a wide range of juveniles size group suitable for stocking of ponds. It has been estimated that the juveniles of *P. monodon* and *P. indicus* constitute 9.6% by weight in the total prawn landings of the lake which, when converted to numbers, the availability would be around 36 million juveniles. If a judicious method of exploitation is adopted without affecting the capture prawn fishery of the lake, stocking material for about 1000 ha. prawn farms in Chilka area can be collected from the lake. Seed prospecting carried out by the All-India Co-ordinated Research Project on Brackishwater Fish Farming revealed that the Palur Canal area is dependable source for collection of *P. monodon* juveniles and Rushikulya estuary and Chilka Lake mouth are strategic sources for collection of prawn post-larvae.

Seeds of the culturable varieties of brackishwater fishes viz- mulltes (*Mugil cephalus, Liza macrolepis* and *M. tade)* sea bass *(Lates calcarifer)* milk fish (*Chanos chanos*) and pearl spot (*Etroplus suratensis*) are available in Chilka lake in appreciable quantity. Particularly mullet fry in large quantits are available near the mouth of Chilka Lake during November to February. Milk fish fry in appreciable quantity are available in the backwaters of Sorala and Sumandi and in Bahuda estuary during April-June.

The present area under semi-intensive and extensive prawn farming together with the programme of Seventh Plan would bring in a total area of 5000 ha. under prawn farming. This would generate a demand for 200 million prawn seed for 2 crops. Therefore, it is quite clear that the seed availability from natural sources would be in-sufficient and the establishment of adequate hatcheries is thus the only resort.

3. Present Status of Brackishwater Fisheries Development in Orissa

3.1. Existing Projects

3.1.1. Experimental Brackishwater Fish Farm at Khiragachha Madeli in Cuttack District

This is the first experimental brackishwater fish farm of the State constructed by the Department of Fisheries reclaming 8.09 ha. mangrove swamp in the year 1958-59. Initially pond ecology and growth and survival of mullets, chanos and sea bass were studied. Although encouraging growth of the said varieties of fishes were recorded, their systematic culture was later affected due to damage of embankments by crabs, rapid siltation, presence of mangrove stumps etc.

3.1.2. All-India Co-ordinated Research Project on Brackishwater Fish Farming at Keshpur in Ganjam District.

This is the first 10 ha. departmental brackishwater fish farm in the periphery of southern sector of the Chilla lake constructed in the year 1961-62. Although the farm is linked with the Chilka lake by a head sluice gate, no exchange of water take place due to absence of tidal effect and the pond water is almost confined type. The Indian Council of Agricultural Research sanctioned the All-India Coordinated Research Project on Brackishwater Fish Farming in Orissa which was operated in this farm since 1976 during Fifth Five Year Plan and continued through Sixth Plan. The sub-centre conducted experiments on nursery rearing of early fry to fingerlings for fin fish and prawn post larvae to juveniles, monoculture and polyculture of selected fish and prawn species with and without artificial feed at selected stocking densities and for selected rearing periods, pond ecology and management and brackishwater prawn and fish seed prospecting.

The results obtained from the research sub-centre indicated that with proper preparation of nursery ponds by resorting to suitable manuring and fertilization the retrieval of prawn juveniles from post larvae stage can be enhanced to over 40%. In monoculture of *P. monodon*, a production of 300-400 kg/ha/year can be obtained and milk fish, a production of over 1200 kg/ha can be obtained. The seed prospecting carried out under the project confirmed that the Palur canal area connecting the Chilka Lake and the Rushikulya estuary is a positive source for collection of *P. monodon* juveniles and the Rushikulya estuary and Chilka Lake mouth are the potential source for collection of post larvae of *P. monodon* and *P. indicus*. It also indicated that the Bahuda estuary and the adjoining creeks are strategic source for collection of *C. chanos* fry.

3.1.3: Pilot Project on Brackishwater Fish Farming at Inchudi in Balasore District

During the Fifth Five Year Plan, under the Central Sector Scheme, one pilot project for Brackishwater Fish Farming was sanctioned for Orissa and the one time grant of Rs. 12.23 lakhs

was released by the Government of India on 23. 3. 1978. The farm construction having facilities for exchange of tidal water was completed during the year 1982 at a total cost of Rs. 18.25 lakhs. Gross area and net water area of the farm are 14.24 ha. and 9.5 ha. respectively. Pilot studies on rearing of prawn juveniles from post larvae stage, monoculture of *P. monodon*, monoculture of *L. calcarifer* and polyculture of mullets and milk fish have been initiated recently in 1984-85.

3.1.4. Brackishwater Fish Farming Projects under area Development Approach Programme

During the VIth Five Year Plan, the Government of India sanctioned a new centrally sponsored scheme on brackishwater fish farming with area development concept for Orissa, during 1982-83 with 50:50 funding basis by the Govenrment of India and the State Government. The Project site has been selected at Mudiratha in the periphery of Chilka Lake where work is in progress in 23 ponds having a total area of 11.50 ha. soon in another cluster of 12 ponds having a total area of 6.0 ha. During the period from 1982-83 to 1984-85, a total allotment of Rs. 14.0 lakhs has been received by the Department of Fisheries for construction of 17.50 ha. brackishwater fish farming project at Mudiratha which is expected to be completed by June 1985. As per policy of the State Government each of the 0.5 ha. size ponds will be alloted to the beneficiaries from target group.

During 1983-84 and 1984-85, monoculture of *P. monodon* was done by seven numbers of IRDP beneficiaries in seven numbers of ponds (3.10 ha.) and on average production of 238.25 kgs. ha/crop has been obtained under confined water management and the gross income per beneficiary has been worked out to Rs 7436 from 0.44 ha. water area.

3.1.5. Prawn Farming Projects under the Scheme 'Economic Rehabilitation of Rural Poor'

Basing on the success of experimentations of prawn culture in confined water ponds in the Chilka Lake periphery, the Government of Orissa have launched a massive programme to rehabilitate 3000 numbers of poorest families from coastal area through prawn culture. Initially, the programme was initiated in 1982-83 and the actual pond excavation work was started in 1983-84 in Puri and Ganjam district. The poorest of the poors from among the rural mass is selected under the scheme on the basis of lowest annual income of Rs. 1200/- per family. Each of the selected poorest beneficiaries is provided with a pond of 0.20 ha. size for prawn culture for a period of ten years. The State Government provides 100% grant to develop the pond and meet the input cost for the first crop of prawn culture. The Government brackishwater land where the pond is constructed is given 10 years lease to the ERRP beneficiary.

So far, 1012 numbers of ponds covering a total gross area of 254.00 ha. and water area of 160 ha. have been developed in Puri and Ganjam district comprising of 32 clusters. The farm area of each cluster ranges from 1 ha. to 37 ha. All the the clusters are located in and around the Chilka lake except for four

which are located in the costal brackish-water area of Ganjam districts. All the 254.00 ha. prawn culture clusters have been designed for confined water management. Since many of the ponds and protection dykes are not completed only 505 numbers of ponds covering a total gross area of 116.58 ha. have been taken up for prawn culture till 1984-85. The ERRP beneficiaries have already raised four crops of *P. monodon* from their ponds and the average yield ranges from 170-500 kg/ha/crop. In Puri district, the average yield has been obtained at 212.7 kg/ha/crop and in Ganjam district, it works out to 180 kg/ha/crop. During these two years, the prawn farmers under the ERRP Scheme have realised gross income ranging from Rs. 1800 to Rs. 5585 per crop from an average water area of 0.16 ha. and the average gross income per poorest family has been achieved at Rs. 2283.00. Average gross and net income per hectare per crop have been worked out to Rs. 14,500 and Rs. 12,500 respectively.

3.1.6. Prawn Farming in Private Sector

The performance of prawn culture by the ERRP beneficiaries in a large number of brackishwater ponds in Puri and Ganjam districts during 1983-84 generated great deal of interests among the private individuals in the coastal districts to take up prawn farming by excavating ponds in their own land or lease-hold Government land. Bankers in the coastal districts also evinced keen interest to finance the prawn farming projects in the private sector with the assistance of the special agencies (BFDAs). Although many individual farmers have developed brackishwater ponds for prawn culture through institutional finance some private people have invested their own resources to develop breckishwater ponds.

So far, 520 private farmers have developed 536 numbers of brackishwater ponds (223.05 ha.) for prawn culture with the assistance of the brackishwater fisheries development agencies in the State. Individual farmers of Balasore and Cuttack districts have mostly constructed ponds having facilities for exchange of tidal waters (tide-fed ponds) whereas farmers of Puri and Ganjam districts have constructed only confined ponds for prawn culture. In Balasore and Cuttack districts, the farmers are culturing both *P. monodon* and *P. indicus*, the percentage of *P. monodon* being more than seventy. Average production from tide-fed ponds has been obtained at 200 kg ha crop. In confined ponds of Puri and Ganjam districts the farmers are culturing only *P. monodon* and the average production has been obtained at 225 kg / ha / crop. The stocking density of prawn juveniles in such semi-intensive type of culture ranges from 10,000-20,000 ha depending on the size of juveniles

3. 1. 7. Pilot Prawn Hatchery at Paradeep

The Department of Fisheries, Orissa has set up a Pilot Hatchery for production of prawn seeds at Paradeep in 1979-80. In total, 48 batches of breeding of *P. monodon*, *P. semisulcatus*, *M. monoceros* and *M. affinis* have taken place in the hatchery so far. Successful rearing upto post larval stage was first achieved in March, 1981 and thereafter in six occasions, post larvae of *P. monodon*, and *M. monoceros*

have been obtained. During Mar-Apr, '84, 70,000 nos. of juveniles of *P. monodon* was produced in the hatchery. Necessary installations of machineries are being made to bring about perfections in the hatchery management.

3.2: Supporting Organisations

3.2.1: MPEDA Regional Centre at Bhubaneswar

The Marine Products Export Development Authority (MPEDA) of Government of India has set up a Regional Centre for Prawn Farming at Bhubaneswar in the year 1979 with a view to promoting prawn farming in the coastal districts of Orissa and West Bengal. Apart from surveying the brackishwater area in the State suitable for prawn farming, it renders assistance in preparing feasibility reports for the interested farmers for availing institutional finance for prawn farming projects. The Centre educates the farmers by giving training on scientific prawn farming and putting demonstrations on farmers' field. It also organises prawn farmers' meet at different prawn farming project area to discuss field problems and generate conciousness among the farmers in scientific prawn farming. This Centre with its technical and engineering staff monitors the construction and management of prawn ponds.

In the Governing Body Meeting of the Brackish water Fisheries development Agency (Puri-Ganjam), Puri held on 18-2-84, it was decided to associate MPE DA Regional Centre at Bhubaneswar in the brackishwater fisheries development programmes of the State more closely. Following suggestions for assistance of MPEDA in promoting prawn farming in the State were made:

1. The MPEDA (PF), Bhubaneswar shall be associated in micro-level survey of brackishwater sites proposed for prawn culture projects when needed by the BFDAs.
2. The MPEDA shall assist the BFDAs of the State in site selection, survey of individual prawn culture projects under bank finance programme.
3. In respect of bigger/medium prawn Culture projects/clusters, the basic plan and design shall be prepared by the MPEDA in association with the BFDAs.
4. The MPEDA shall continue its assistance in imparting training to the prawn farmers in collaboration with the BFDAs.
5. The MPEDA should provide transport support in seed supply during heavy demand period on no loss and no profit basis.
6. Bulk requirement of inputs should be supplied by the MPEDA on no loss and no profit basis.

The Regional Centre at Bhubaneswar has been assisting the BFDAs more effectively in the development of prawn farming in the State. So far 634 farmers have been trained by MPEDA, in scientific prawn farming and regular monitoring of pond/project construction and farm management is done by its engineering and technical staff in association with the staff of the BFDAs. During 1984-85, the Regional Centre of MPEDA has supplied inputs like feed and fertilizers to 319 prawn farmers under BFDAs scheme on no loss and no profit basis. Farm designing for large salt pens and bigger

projects over 10 ha. area are being prepared by this centre for execution during the current year.

3.2.2: CIFRI Sub-Centre (Brackishwater Fisheries) at Puri

The brackishwater fisheries unit of CIFRI(ICAR) was established at Puri in 1982. The sub-centre is engaged in seed prospecting, artificial propagation of commercial varieties of fin fishes and management of prawn hatchery. The results finding of this research unit would be of much help to the promotion of prawn farming in the State.

3.2.3: Orissa Maritime & Chilka Area Development Corporation Ltd., Bhubaneswar

The Orissa Maritime & Chilka Area Development Corporation Ltd., (OMCAD) Bhubaneswar, apart from deep sea fishing and processing and export of marine products, has planned to develop 460 ha. brackishwater prawn farming projects in two sites in Chilka area during the 7th plan in collaboration with M/s. Tata Oil Mills & Co., (TOMCO). The project report for gross investment of Rs. 576.16 lakhs has been approved and the Government of India have agreed to contribute Rs. 112.90 lakhs. These two large projects will have adequate pumping facilities for exchange of water. The project will have its own hatchery to meet the seed requirements. The corporation will manage the farms for six years and thereafter the ponds will be alloted to the individual farmers from the weaker sections.

3.2.4: Brackishwater Fisheries Development Agencies (BFDAs)

The State Government have set up two new special Agencies (BFDAs) for four coastal districts with their registered headquarters at Puri and Balasore to look to the exclusive needs for development of brackishwater fisheries in the State. The Agency provides technical assistance to the farmers right from selection of site till harvesting and marketing of prawns through the entire duration of culture. Extention services input supply including seed, training to the farmers etc., are also provided by the Agency. It also arranges bank credit for the farmers to develop brackishwater ponds and provide subsidy assistance @ 25% on the total project cost up to a limit of 2 ha. per individual project. Besides, it arranges long-term lease of Government brackishwater area for interested farmers.

Each agency (BFDA) is managed by a 14-members committee of which the concerned District Collector is the Chairman. The agency has three wings viz., executive wing, engineering wing and extention wing. It is decided by the Government that each of the four coastal districts will have one BFDA and the organizational set up of the agencies will be further strengthened during the 7th Plan. Presently, these BFDAs are exclusively looking after the brackishwater fisheries development programmes in each of the coastal districts.

3.3 Government Policy for lease of Brackishwater Area

The Government of Orissa have notified principles for lease of brackish water area in the state exclusively for

prawn/fish farming in 1981 as outlined below :

i) Term of lease shall be for a long period of 15 years which can be renewed subject to the satisfaction of the State Government.

ii) 75% of the suitable brackishwater land requiring comparatively lower scale of investment for development shall be kept reserved for allocation to the ERRP beneficiaries, poor fisherman and other weaker sections of the Communities.

iii) Lease shall be granted to the small entrepreneurs on self employment scheme/private individuals, who are prepared to put in their investment and produce technicially sound and economically viable schemes for brackishwater prawn culture shall be allocated suitable land, not ear-marked for weaker sections at the rate of not more than half ha. each.

iv) Lease shall be granted only on recommendation by the Fisheries Department/Authorised Agency like BFDAS.

v) Established entrepreneurs/firms/companies/corporations interested in taking up brackish water fish and prawn culture shall be allowed to take lease of area upto a maximum of 80ha. per unit provided they have viable technical project reports, adequate seeds, capital base and commensurate technology. Generally such area, where substantial investment is required shall be leased out under this principle.

vi) The bigger entrepreneurs shall not be allowed to collect more seeds than is required for their farms and they shall establish their own seed farms.

vii) The land leased out for the purpose shall be summarily resumed if the lesee fails to develop the entire area within three years of the lease.

viii) The premium for the land to be leased out shall be at a flat rate of Rs. 625 per ha. and the annual ground rent shall be chargeable at the rate of 1% of the premium.

The lease policy for brackishwater area has been in force since December 1981 and till now. 78.75 ha. have been leased out to 270 numbers of private individuals for prawn farming. The Government have also decided that area indentified by fisheries deptt., as suitable for brackishwater prawn/fish culture, should not be leased out for agricultural or other allied purposes including salt extraction.

3.4: PRAWN CULTURE PRACTICES AND AREA UTILISED

The available brackishwater area in the State present two distinctly different locational characteristics. The vast stretch of low-lying area bounded within the inter-tidal zone of the northern coastal belt can suitably be developed into tide-fed farms/ponds where the normal tidal amplitude ranges from 1.5 - 2 mtrs. Taking the advantage of tidal submergance of vast low-lying coastal area in

Balasore and Cuttack districts, many farmers have been culturing prawns along with other miscellaneous fishes by bunding such area and trapping and holding the seeds of prawns and fishes. Besides, such traditronal cultural practices, those area have been found suitable for scientific prawn farming in tide-fed ponds. A part of the mid-coastal belt and the southern coastal belt of the State present a different situation where the diurnal tidal cycle has medium and low amplitude. Suitable brackishwater area are in this part of the coast line are mostly located away from the highest higa tidal mark facilities for exchange of tidal water in these ponds hardly or do not exist. Therefore, prawn farming in confined water ponds or with pumping facilities is the only alternative. In general, prawn cultural practices in Orissa are of site specific and the following are the present practices:

3.4.1: Traditional Practices

People of coastal villages in Balasore and Cuttack districts are quite familiar with the traditional culture of prawn and fish in the low-lying area/ paddy fields which is based on the trapping and holding methcd. Immediately after the last monsoon flood such area which are located within the range of diurnal tidal cycle, are enclosed by bunding and keeping provision to allow tidal water into the enclosed area. Young ones of prawns and fin fishes are trapped in the enclosures during spring tide and they are allowed to grow there for 70 to 100 days. The most common species of prawns are *P. monodon*, *P. indicus*, *Metapenaeus monoceros* and *M. dobsoni* whereas *M. cephalus*, *L. macrolepis*, *L. tade*, *Chanos chanos*, *Mystus spp*,, *L. calcarifer* form the composition of fin fishes in the traditional culture. In the prawn catch, *P. monodon* constitutes 30-60% and among fin fishes in the traditional culture, *Lates calarifer* forms the major portion being more than 50%. Nearly 840 ha. area in four coastal districts are presently being utilised for traditional prawn and fish culture. The average yeild of prawn and fish from such cultural practices is about 75 kg/ha. and 500 kg/ha. respectively.

3.4.2: Extensive Prawn Farming

Although in some part of coastal area in Cuttack district prawn culture in traditional method was further improved by selective stocking in the past, many people have followed almost controlled type culture in large shallow patches in the recent years which receives tidal water during spring tide. The well bunded shallow area receive tidal water in post monsoon period through split bamboo screens in order to check entry of predaory fishes and once the enclosed area is full with tidal water, the inlet is closed with fine bamboo screen. Prawn seeds collected from natural sources are stocked in those enclosures, on an average, @ 30,000-40,000 / ha. Exchange of tidal water takes place periodically and the prawns are allowed to grow for 80-100 days without any supplemental feeding and manuring. It has been observed in many cases that eels and *Mystus sp.* enter the enclosures even though the screen. Average yield is estimated at 105 kg/ha.

In the peripheral area of Chilka lake which are submerged in monsoon, shallow pits ranging in area from 0.4 to 5 ha. are

enclosed by temporary earthen bunds towards October. About 0.5—0.8 m. water remains in those enclosures upto December-January. Farmers stock them with selected prawn juveniles, particulary with *P. monodon* at an average rate of 25000-30000 per ha. Such area in Chilka lake periphery having clayee soil base with rich detritus and benthic food provide suitable enviornment for growth of prawn. Culture is carried out without feeding and manuring and the crop is harvested normally after 70-90 days. Towards November and December, when the water depth reduces repidly, preying by fish eating birds causes the major hazard. This type of extensive prawn culture in the Chilka lake area is a recent development of 2-3 years. Prawn culture in 147 nos. of confined ponds in the Chilka periphery under ERRP/ADAP Scheme in 1983-84, generated great deal of interests among the people from nearby villages to go in for such type of extensive prawn culture. From a sample survey conducted by the BFDA (Puri/Ganjam) during 1984-85, it is estimated that the average yield of prawns from such culture system is around 120 kg. per. ha.

3.4.3: Semi-Intensive Culture :

After succesful experimentation of prawn culture in the All-India Co-ordiated Research Project at Keshpur and subsequent field demonstrations of monocultnre of *P. monodon* in few confined ponds near the Chilka lake and Palur canal during 1981-83, a massive programme for prawn culture in confined ponds under the ERRP scheme was launched by the State Governmet in 1982-83 with 100% financial assistance. The first time large scale prawn culture in confined ponds was thus started in the Chilka lake area and in Bahuda estuaries are in 1983-84 under the technical assistance of BFDA. Quite a good number of new confined ponds have also been developed through Bank finance and own resources, in the private sector where semi-intensive prawn culture is practised. The Regional Centre of MPEDA, Bhubaneswar also assisted in the programme by giving necessary training to the beneficiaries and monitoring the pond management. The idea of resorting to confined pond culture of prawns was to minimise the extra capital/ operational costs on pumping. Till March '85, 331 numbers of confined ponds in the private sector through bank finance and own resources have been developed in the vicinity of Chilka lake for prawn culture.

The newly excavated ponds ranging in sizes from 0.12 to 0.70 ha. without having any provission for water exchange are treated with quick lime just before or mmediately after the first monsoon rain. After accumulation of rain water in the pond, the water salinity gradually increases being influenced by the soil salinity During monsoon, when the lake water reaches the peripheral dykes of the farm/ cluster water level in most of the marginal ponds increases due to seepage of lake water into the ponds. The pond water maintain a medium range of salinity between 10 - 18 ppt. during culture period of first crop (Jul-Aug to Oct-Nov.) without showing any sudden fluctuation. During the period second cropping (Oct-Nov to Jan-Feb), the average salinity rises hardly beyond 22 ppt. All the ponds dry up during Mar-Jun when the top soil

contains high salinity. Again when it receives fresh rain water during monsoon, the water becomes brackish immediatly. Entry of predatory fishes in to the ponds is fully controlled. Manuring with raw cow-dung and fertilization with urea and superphosphate at low doses are resorted to. In many ponds good results have also been achieved during 1984-85 without applying inorganic ground nut cake, snail meat, prawn head and dry fish powders are provided as suplemental feed. In most cases, ground nut cake and snail meat are used as feed Normally prawn juveniles ranging in sizes from 30-60 mm are stocked at densities ranging from 10,000-18,000 ha. Harvesting is effectively done by using Chilka type traps which ensures almost 100% catch The retrieval is high being more than 60%. Presently only monoculture of *P. monodon* is carried out in confined ponds developed in Puri and Ganjam districts. Average yield of *P. monodon* from confined ponds has been obtained at 225 kg/ha/crop. The actual average expenditure on inputs and harvesting works out to around Rs. 4000 ha.

In Cuttack and Balasore districts, semi-intensive culture of both *P. monodon* and *P. indicus* is also followed in tidal ponds. But many farmers are preferring polyculture of prawns with fin fishes like mullets and milk fish. In monoculture of *P. monodon* and poly culture of prawns and fishes average production of prawns @ 180 kg ha crop and 130 kg/ha/crop respectively are obtained. The average total production of prawn and fish per ha. is around 1200 kg.

3.4.4: Pen Culture

Chilka lake provides the most favourable ecological conditions for natufral recruitment and growth of prawns It offers the greatest scope for culturing prawns in pens. In fact, large numbers of 'JANO' fisheries operated in the Chilka lake since centuries back involves the principles of pen culture excepting for holding the prawns and fishes of mixed varieties Experimental results indicated that a production of 1000 kg/ha 2 months is feasible if managed scientifically under proper care. The State Fisheries Department also carried out pen culture of *P. monodon* in the southern and central sectors of Chilka lake since 1981-82 and the results obtained are encouraging. The production above 400 kg ha 90 days has been found feasible.

After the wide scale prawn culture in confined ponds was started in the Chilka lake area, many fishermen have started erecting medium size pens (9 06 - 0.40 ha) with bamboo screens in the shallow waters of the lake and stocking the pens with advanced juveniles of *P, monodon* (50 - 70 mm). The stocking density ranges from 20000 - 30000/ha. Since the predatory fishes are not completely removed from the pens, the production is affected and shows wide variations (80 kgs - 200 kg/ha).

3.5: AREA UTILIZED FOR PRAWN FARMING

Although the traditional prawn culture in a limited scale was carried out by the coastal farmers since from past several years, extensive and semi-in-

tensive prawn farming are the recent practices in Orissa. Virtualy scientific prawn farming in semi-intensive method was only started by thefarmers in 1983-84. Presently, a total of 1446.48 ha. brackishwater area in the State are used for prawn culture of all types and its sector - wise break-up is shown below in Table-III :

Table III

Sector/Scheme	Brackishwater area under culture (ha) (Gross area)	System of Culture
1. Govt. brackishwater farms	32.33	Semi-intensive
2. State sponsored scheme		
Economic rehabilitation of rural poor (ERRP) with 100% Govt. assistance	254.00	-do-
3. Centrally sponsored scheme		
Area Development Approach Programme (ADAP) with 50 : 50 share by State and Govt. of India	11.50	-do-
4. Private Sector		
Through bank finance with 25% subsidy assistance from BFDA	91.00	-do-
Through own resources (without bank finance and with technical assistanbe of BFDA)	132.05	-do-
Prawn culture by private farmers in enclosed expanse of brackishwaters by selected stocking of prawn seeds but without manuring and feeding	85.60	Extensive

'bhery' type prawn and fish culture in wild impoundments of brackishwaters	840,00	Traditional
Total :::	1446.48	

3.6 Prawn Production from cultural Practices

In traditional and extensive cultural practices normally the farmers harvest only one crop in a year. In semi-intensive cultural practices although two crops are harvested, some farmers fail to raise the second crop due to inadequate water in the confined rain-fed ponds during Jan-Feb. Therefore, the average production of prawns from both traditional and extensive culture estimates at 100 kg/ha. Althouth around 500 kg/ha/year production of prawns from semi-intensive culture is obtained the average annual production per ha. comes to about 350 kg. which has been worked out from the actual informatiohs collected.

The total production of prawns from culture sources in the State at present has been estimated at 192.7 tonnes per annum as presented in the Table-IV.

Table-IV

System of Culture	Area under Culture (ha)		Qty. of prawn produced (MT)
	Gross	Net	
1. Semi -intensive	520.88	364.5	127.5
2. Extensive	85.60	68.4	8.2
3. Traditional	840.48	760.0	57.0
Total :::	1446.48	1192.90	192.7

3.7 Bankable Schemes for Prawn culture Projects

In a span of two years, the successful results obtained from more than 1000 prawn culture ponds in the State operated under different Government subsidised schemes have attracted the financial institutions to invest credit in prawn farming development. The brackishwater fisheries development agency (BFDA), in consulation with the Marine Products Export Development Authority (PF), Bhubaneswar has prepared three model bankable schemes for development of prawn farmlng projects through institutional finance and submitted to the

NABARAD for approval and providing refinance facilities to the participating banks. The schemes have been cleared by the NABARAD at their Bhubaneswar regional office and sent to their head office at Bombay. In the meanwhile the NABARAD have communicated sanction letter to Puri Gramya Bank for financing 60 ha. project area during 1984-85 in Puri district. Refinance at the rate of 90% of the investment will be provided by the NABARBD at a liberal rate of interest as under:

Rate of interest	Small Farmers	Medium Farmers	Other Farmers
NABARAD to Bank		6.5%	8.0%
Bank to beneficiary		10.0%	12.5%

The loans from the financial institutions will be issued to the borrowers on hypothecation of prawn crop/group/ gurantee and/or mortgage of immovable property including lease documents.

Depending on the different locational characteristics of the brackishwater area in the State, three different model bankable schemes have been prepared for development of prawn ponds and the first two are already operative. The summary of the unit cost and economics of the Schemes as recommended by the BFDA are as below:

1. Scheme for Confined Water Pond:

Unit: 1.0 Ha.

i) Capital investment (Earth work, farm shed and lease value) — Rs. 29, 375.00

ii) Operational Expenditure: (Inputs for first crop, harvesting, watch and ward) — Rs. 5, 750.00

Rs. 35, 125.00

say Rs. 35, 000.00

iii) Annual Income:

Sale of prawn from 1st crop @ 50% retrieval with average growth of 25 g/90-110 days at 20,000/ha. stocking 250 kgs. @ Rs. 60/- per kg. — Rs. 15,000.00

Sale of prawn from 2nd crop @ 40% retrieval- 200 kg. @ Rs. 60/- per kg. — Rs. 12,000.00

Rs. 27,000.00

iv) Gross Annual Income after meeeting the operational cost for two crops — Rs. 15,500.00

2. Scheme for tide-fed Pond :

i) Capital Investment : (Site clearance, earth work, feeder channel, sluice gate, watching shed, lease value etc.,)	Rs. 38,300.00
ii) Operational Expenditure : (Inputs, harvesting charges, Watch and Ward, etc.,)	Rs. 5,500.00
Total	Rs. 43,800.00
iii) Annual Income : Sale of 450 kgs. of prawns from 2 crops @ Rs. 60/- per kg.	Rs. 27,000.00
iv) Gross Annual income after meeting operational cost for 2 crops	Rs. 16,000.00

3. Scheme for Pen Culture :

i) Cost of pen construction (Split bamboo screens, synthetic monofilament netting cloth of 1 mm mesh bamboo poles, labour charges, etc.,)	Rs. 16,250.00
ii) Operational Cost (seeds and other inputs, harvesting charges, watching, etc.,)	Rs. 4,600.00
	Rs. 20,850.00
iii) Income (from single crop) Sale of 300 kgs. prawns @ 40% retrieval with average growth of 25 g. @ Rs. 60/- per kg. (Stocking density : 30,000/ha,)	Rs. 18,000.00
iv) Gross Annual Income after meeting the operational cost	Rs. 13,400 00

Economics :

Under the existing circumstances, it is possible to harvest two crops in a year. The total production from 2 crops in both confined water and tide-fed ponds would be 450 kg/ha which will fetch an income of Rs. 27,000/- in each case at an average selling price of Rs.60/- per kg. This selling price is considered rather low when the average price of pond-grown tiger prawn is not less than Rs. 70/- per kg. Although bank loan is availed by the farmer for capital investment and first crop inputs, the total recurring expenditure of two crops has been taken into account for working out of economics.

Since the BFDA is providing 25% subsidy upto 2 ha. limit on every individual project, the loan component for confined water and tide-fed pond would be Rs. 26,250/- and Rs. 32,850/- respectively. For the above mentioned bankable schemes, the IRR and B. C. ration ranges from 37 - 53% and 1.6 : 1 - 2.1 : 1 respectively. The total loan with interest (12.5%) can be easily repaid in a period of 5 years leaving a cumulative net surplus in the first 5 years which ranges from Rs. 34,744 to Rs. 45,497/-

3.7.1: Participation of Financial Institutions

After the setting up of two special agencies (BFDAs) for development of brackishwater prawn/fish farming in the State in 1983, the bankers have shown interests in/financing the brackishwater prawn/fish farming projects sponsored by the agencies. The bankable prawn farming schemes are presently sponsored to the financing banks by the BFDAs for credit assistance to the farmers. During a short period of two years (1983-84 to 1984-1985), 18 numbers of banks have participated in the programme. So far, 1004 nos. of schemes for 536.32 ha. area and Rs. 105.926 lakhs loan have been sponsored to banks. Of this, the bankers have sanctioned 360 cases for 182.65 ha. project area and credit of Rs. 37.18 lakhs. Till now, a total of Rs. 22.724 lakhs bank loan disbursed to the borrowers for development of prawn culture ponds. The present progress of brackishwater pond development through institutional finance in Orissa has been shown in Appendix- I & II

4. SEVENTH FIVE YEAR PLAN SCHEMES FOR BRACKISHWATER FISHERIES DEVELOPMENT IN ORISSA

Brackishwater Fisheries Development has made a begining in Orissa during VI Plan. Although 1446 ha. of brackishwater area is presently utilised for prawn culture under all systems in the state, scientific prawn farming in semi-intensive method has been developed in 520.88 ha. by end of the VI Plan period.

It is proposed to develop 4000 ha. brackishwater area for scientific prawn/fish farming during the 7th plan period. The total plan out lay for the brackishwater fisheries development in the State has kept at Rs. 359.77 lakhs. The programmes and lay-out are summarised as below :

4.1 : Creation of BFDA for all Coastal Districts :

Two BFDAs have been created for four coastal districts. The present administrative set up finds of difficulty to cope with the technical supervision of work in four districts. It is, therefore proposed to create two more agencies for Cuttack and Ganjam districts. The total financial provision for establishment and contigencies is Rs. 66.4 lakhs.

4.2: Subsidy Schemes for Prawn Farming:

The 4000 ha. area proposed to be developed during VII Plan with the assistance of 4 BFDAs will require subsidy support. Out of the total of 4000 ha. some area will be developed through State and Central assistance and some private individuals will develop ponds/farms by utilising their own resources. The BFDAs will administer subsidy for all category of farmers for the remaining area to be developed through institutional finance. All the subsidy assisted schemes will be sponsored to banks by the BFDAs. Atotal provision of Rs. 72.60 lakhs has been proposed for subsidy assistance.

4.3: Area Development Approach Programme (ADAP)

In total, 627 ha. of brackishwater ponds will be developed for prawn farming with the GOI assistance under the Centrally sponsored scheme. The farms will be constructed at different locations, mostly in tha periphery of Chilka lake. The capital cost will be shared by the GOI and the State Government on 50:50 basis. The ponds after construction will be given on lease to more than 1200 beneficiaries from weaker sections. The construction work will generate 5.60 lakh man-days. Total provision proposed under the programme is Rs. 168.0 lakhs.

4.4: Renovation and Maintenance of Pilot Brackish Water Fish Farm at Inchudi

A provision of Rs. 2.77 lakhs has been proposed for maintenance of the existing brackishwater fish farm at Inchudi (Pilot Project) in order to make the farm suitable for pilot studies during VII Plan.

4.5: Construction of Prawn Hatchery

Development of 5000 ha. brackishwater area including the area developed during VI Plan will call for supply of prawn seeds to the tune of 200 million (for double cropping) for which construction of additional prawn hatcheries will be required. Rs. 40.0 lakhs provision has been kept for construction of two hatcheries. One new hatchery at Gopalpur and extension of existing hatchery at Paradeep will be taken up. The construction work will generate 1.32 lakh man-days.

4.6 Development of Keshpur Brackishwater Fish Farm

Provision of Rs. 20 lakhs has been kept for renovation and expansion of Keshpur Farm for carrying out research works and rearing of prawn seed.

4.7 Renovation of Palur Canal

An amount of Rs. 14.0 lakhs was provided for renovation of Palur Canal for free migration of prawn and mullet seeds into the Chilka Lake through Rushikulya estuary during VI Plan. This

work will continue in VII Plan and dredging of Palur Canal will be taken up. The year-wise plan outlay as proposed will be as under:

Year	1985-86	1986-87	1987-88	1988-89	1989-90	1989-90
Outlay (Rs. in lakhs)	31.38	63.24	90.95	83.25	90.95	359.77

4.8: MPEDA Assistance During VII Plan*

During VII Plan, the MPEDA has made a total provision of Rs. 800.0 lakhs for providing financial and technical assistance in prawn farming in the country. The anticipated share of Orissa in the Plan Programme will be around Rs. 60.0 lakhs as summarised below:

1.	Establishment of hatchery (total cost will be Rs. 50.00 lakhs per hatchery and the State government will bear Rs. 20.00 lakhs.) After construction, the hatchery will be handed over to the State for management)	Rs, 30.00 lakhs (Capital Cost)
2.	Financial assistance for setting up of seed banks in private sector (for 3 seed banks)	Rs. 0.60 lakhs
3.	Subsidy assistance for prawn farming in private sector. (about 150 ha. to be developed. Small and marginal farmers will be eligible for 75% subsidy and for big farmers - 50% subsidy)	Rs. 30.00 lakhs
		Rs. 60.60 lakhs

5. Requirement Of Technical Man Power:

Prawn farming is a highly technical operation where a number of problems have to be encountered and solved. Management of prawn culture farms being location specific a pre-investment survey with regard to site suitability and choice of management practices has to be carried out by experienced technical personnel. This is also imperative in the context of capital intensive programme. For smooth and effective implementation of the programme of developing scientific prawn farming in bigger dimension, suitable area, locational features, soil atlas, etc., for the coastal brackishwater area

* This proposal have been slightly modified. The details are available in MPEDA.

of the State is also necessary. The extension services should be strengthened for transfer ot technology in the T & V System. Above all, the designing and construction of brackishwater projects under different locational conditions requires specialised aquaculture engineers.

In Orissa, although the State Government have created two agencies (BFDAs) during the VI Plan and proposed to create two more agencies in the VII Plan period, the technical staffing pattern is quite inadequate to cope with the massive development programme proposed for the VII Plan. The Regional Centre for Prawn Farming of MPEDA at Bhubaneswar with a core staff is also not capable enough to assist the State Government in the programme. The MPEDA with its' ambitious plan to develop prawn farming in the country should assist the State Government by strengthening the engineering wing of the Bhubaneswar centre and establishing a standard soil laboratory.

In consideration of the above needs both field extension workers and extension subject matter specialists should therefore be well qualified, trained and experienced and their number be related to the number of prawn farmers in the State. On the basis of one extension worker for each group of 250 farmers and four groups of subject matter specialists for four coastal districts, the requirement of extension personnel may be assessed. Subject matter specialists in prawn biology, brackishwater pond chemistry, farm engineering and nutrition may be considered. Basing on the above suggestions, the technical man power required for Orissa State during VII Plan can be projected as under:

Technical man power	1985-86	1986-87	1987-88	1988-89	1989-90	Total
1. Subject matter Specialist (Biology)	1	2	1	—	—	4
2. Subject matter Specialist (Pond Chemistry)	1	2	1	—	—	4
3. Subject matter Specialist (Pond Engineering)	1	1	2	—	—	4
4. Subject matter Specialist (Nutrition)	1	2	1	—	—	4
5. Extension Worker (FEO)	14	16	20	20	10	80
6. Extension Super visor (DSF) (One per 1000 farmers)	4	4	5	5	3	21

7. Engineering Supervisor (Jr.ES) @ 1/250 ha.	3	3	4	4	2	16
Total	25	30	34	29	15	133
Area proposed to be developed (ha)	700	800	1000	1000	500	4000

6. CONSTRAINTS & SUGGESTIONS:

6.1: Infrastructure Facilities

Although vast potential brackishwater area exist in the coastal districts of the State, all weather road communications to most of the suitable sites do not exist which restricts the area development,. Therefore, development of communication facilities to potential brackishwater area in the coastal districts should be taken up by the Govt on priority basis. Assured supply of quality seed to the farmers during the culture season, is the most important need which forms the production base. As against the existing prawn seed potential of 130 million from natuaral sources the anticipated demand in the context of bringing in about 5000 ha area under prawn farming during 7th plan would be about 200 million. This wide gape has to be bridged up by establishing adequate prawn hatcheries and supplying hatchery-produced prawn seeds. The collection of seeds from natural sources need be organised in the private sector with the financial support from Govt. agencies.

Successful scientific prawn farming is possible by better water management and supplemental feeding with quality artificial feed. Farmers are finding difficulties in getting ready made prawn feed at their nearer places. Presently, when a begining has been made in prawn Farming in the State with a limited area development, supplemental feeding by ground nut cake and snail meat collected locally has been possible, but in near future this will pose serious problem when area under semi-intensive culture would increase. Therefore, effective prawn feed at a subsidised price in sufficient quantity should be made available to the farmers.

Scarcity of fresh water in the selected project sites is another major problem. Adequate facilities for provision of fresh water at the brackishwater project sites has to be provided. It has already been experienced in the Chilka area that in The absence of fresh water at many work sites, the labourers are not willing to work and the project construction is seriously hampered.

Construction of protection embankments of farms in the brackishwater area requires larger capital investment. The small and marginal farmers who are going in for developing prawn farms

in the lease-hold brackishwater area, are unable to construct protection dykes. Bank loan for this extra heavy capital cost cannot be extended to them beyond the recommonded unit cost since it will cost high for an individual farmer to repay the loan. Government agencies like DRDA should come forward to provide financial support for this.

In the area where facility for exchange of tidal water does not exist the farmers can go in for developing either confined water ponds or pump-fed ponds for prawn culture. Many farmers in such area, particularly in Chilka area may prefer to have pumping facility at extra cost to get additional prawn yield from 2-3 crops. Availability of electricity at the project site is therefore suggested.

Prawn farming being a capital intensive activity adequate institutional finance should be made available to develop this productive, income and employment generating sector. Since 4000 ha. area has been proposed for development of prawn farming in the VII Plan and even if 50% of the target is desired to be achieved, it will call for a huge quantum of credit investment which can be estimated at Rs. 8.0 crores at the rate of Rs. 0.40 lakh/ha. It is therefore, suggested that the financial institutions in consultation with the NABARAD may formulate suitable banking plan with commitment for refinance for successful implementation of the programme.

APPENDIX - I

Progress of Brackishwater Pond Development for Prawn Farming in Orissa Through Institutional Finance and own Resources

(Aug '83 - Mar '85)

Sl.	Progress		Coastal Districts				Total
			Balasore	Cuttack	Puri	Ganjam	
1.	Long term iease of Govt. brackishwater area recommended by BFDA	No :	54	82	286	5	427
		Area (ha) :	27.00	41.60	87.37	2.47	158.44
2.	Long term lease of Govt. brackish water granted	No :	—	—	268	2	270
		Area (ha) :	—	—	77.67	1.08	78.75
3.	Bankable Schemes recommended to Banks	No :	453	296	106	149	1004
		Area (ha) :	217.44	175.82	66.80	76.56	536,62
		Amt. (Lakhs)	42.78	33.52	14.16	15.47	105.93
4.	Prawn Culture project sanctioned by banks	No :	187	74	42	57	360
		Area (ha) :	90.83	36.83	26,98	28.01	182.65
		Amt. (Lakhs)	17.92	7.88	5.35	6.03	37.18
5.	Subsidy released (Amt. in lakhs)		2.77	0.72	0.74	0.27	4.50
6.	Prawn Pond developed i) through bank finance	No :	146	17	30	37	230
		Area (ha) :	47.69	10.14	14.63	18.53	90.99
	ii) through own resources	No :	14	28	186	78	306
		Area (ha) :	6.78	15.10	82.68	27.49	132.05
	Total :	No :	160	45	216	115	536
		Area (ha) :	54.47	25.24	97.31	46.02	223.04
7.	Prawn Farmers Trained	:	107	22	309	226	664

APPENDIX - II

Participation of Banks in Brackishwater Pond Development Programme in Orissa

(Aug '83 - Mar '85)

Sl.	Name of participating Bank	Project proposals sponsored by BFDAs		Projects sanctioned by B. Bs.	
		No.	Loan amt (Rs. in lakhs)	No.	Loan amt. (Rs. in lakhs)
1.	State Bank of India	168	16,859	79	5.488
2.	Union Bank of India	40	5.420	13	2.181
3.	U. Co. Bank	82	7.729	33	2.854
4.	United Bank of India	130	15.429	34	4.600
5.	Central Bank of india	9	1.252	1	0.119
9	Bank of Baroda	43	3.307	30	1.916
7.	Indian Overseas Bank	24	2.997	21	2.711
8.	Syndicate Bank	99	7.268	66	4.689
9.	Andhra Bank	7	0.623	1	0.123
10.	Allahabad Bank	7	2.052	3	0.279
11.	Canara Bank	8	0.730	-	-
12.	State Coop-Bank	110	9.507	27	2.805
13.	State Land Devt. Bank	4	0.383	2	0.186
14.	R R Bs.	267	23.172	47	4.465
15.	Orissa State Fin. Corprn.	1	3.310	-	-
16.	Vijaya Bank	2	20.343	-	-
17.	Bank of India	2	0.304	-	-
18.	United Industrial Bank	1	5.245	1	4.460
	Total :::	1004	105.930	360	37.180

PRESENT STATUS OF PRAWN FARMING IN WEST BENGAL

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Introduction

From time immemorial traditional type of brackishwater fish farming or bheri culture has been practised in West Bengal. No. so-called management practices were, however, followed by them earlier and with the recent development of brackishwater fish farming technology they have adopted certain measures which are within their means and commercially applicable and at present 25,000 ha could be brought under brackishwater fish farming. The total estuarine and brackishwater areas in West Bengal is 405 thousand ha ((Anon, 1981)). Brackish water areas under culture are confined in the two coastal districts - 24 Paraganas and Midnapore and mainly in north 24 Paraganas. The whole brackishwater areas in West Bengal is divided into three broad zones -

1. High tidal amplitude with high salinity.
2. Medium tidal amplitude with medium salinity.
3. Low tidal amplitude with low salinity.

The development of brackishwater fisheries in West Bengal is in fact centered around the areas of low tidal amplitude with lower salinity and that too by the private fish farmers. One of the reasons for the development of these areas is the low capital input and lesser cost of operation and maintenance. Taking the advantage of low salinity, along with brackishwater prawns different types of fishes are also grown there. Some areas are under paddy-cum-prawn farming. The present rate of production of prawns is 200-400 Kg/ha.

The development of brackishwater fisheries in high tidal amplitude areas demands elaborate protection from the different vagaries of the nature so the cost element is higher and therefore, private entreprises are a few in these areas, whatever development that has been done in these areas are mainly by the Govt or by Govt. agencies.

Fish Seed Sesources:

The Hooghly-Matlah estuarine complex of West Bengal supports the World's most luxuriant mangrove vegetation, the Sunderbans. It is now a well known ecosystem of the tropics. Extensive survey on the hydrology and productivity of this estuarine back waters has been done partly and is still being oontinued

(Bose and Mitra, 1985). The study of the seasonal fluctuction of the hydrological parameters like temperature salinity, dissolved oxygen, pH etc. and the faunistic and floristic survey of planktonic and benthic types at different centres of the estuary for the last ten years have established the high productivity of the area for the migration of brackishwater fish seed. CIFRI is also conducting a regular survey of the seed resources n this area as a part of their All India Co-ordinated Research Project on brackish water fisheries.

Present Developmental Work:

These areas are highly potential for brackishwater fisheries development and are not suitable for agriculture or any other purpose. Prawns being a foreign exchange earner which can improve the economic condition of the local people who live much below the poverty line, from the Fisheries Deptt,, Govt. of West Bengal much emphasis has been given for the wide scale development of these areas for brackishwater fisheries. Necessary engineering survey to find out the suitable areas has already been started - three different areas have been given to IIT, Kharagpur recently in this regard. They are very helpful to us and within a very short period of time, we have received the preliminary report about the feasibility of two sites - Kakdwip char and Chandanpiri mudflat and he other area, Herobhanga, is under study with the help of photoimageries and other aerial survey records.

Plan Of Action:

Though West Bengal is considered as one of the leading States in brackishwater fish farming having maximum area under this type of culture for several generations, yet I have no hesitation to mention that the progress on development in this sector is very slow compared to our achievement in freshwater sector specially in the production of carp seed.

To augment its development, I feel that we should give a serious thought to this following points regarding the plan of action.

As brackishwater fishery is subjected to fluctuating environment and greater number of variables which makes it very tricky to handle, to find out suitable technology the entire farming process should be considered as a system and detailed study of each component of the system and their interactions should be carried out by the concerned Central and State Govt. organisations and for which necessary funding must be arranged. The outcome of this study will help us in increasing the productions of the existing waterbodies.

2. To bring new areas under culture the State should be provided with necessary trained personnel for the formation of a cell particularly for the macro and micro level survey work, by which identification of suitable areas can be done.

The cost for the formation of the Cell should be borne by the Central Govt. or MPEDA.

3. Formation of an agency under the State Govt. exclusively for the development of brackishwater fisheries be created and for which necessary economic support should be provided by the Central Govt. at the initial stage.

4. For fhe last few years, it has frequently been observed that the culture programme of brackishwater fish farming in East Bengal is hampered due to non-availability of stocking material in time. *Penaeus monodon* post larvae which was available at the rate of less than Rs 5/- per thousand are being sold at the rate of more than Rs. 100/- per thousand. One of the reasons, is the rapid extension of prawn farming in the recent years due to the high demand of prawn in the export market. To assure a timely support of quality prawn seed of required amount, without disturbing the ecological balance, setting up of prawn hatchery is essential. Simultaneously necessary measures should be taken for the conservation of natural resources and its judicious exploitation for a sustained yield.

Development Of Fresh Water Prawn Farming In West Bangal:

Fresh water prawns, 'Scampi' has a good export market. So popularisation of its culture can serve the same purpose as brackishwater prawn farming can do. In West Bengal, culture of 'Scampi' has been undertaken in fresh water ponds for a long time but no special effect has been taken to develop it. It has immense potentiality from the point of availability of seed and culturable waterbodies but it has not yet been tapped properly.

In West Bengal, we get two large sized prawns viz. *Macrobrachium rosenbergii* and *M. malcolmsonii* and one medium sized prawn viz. *M. rude*. apart from other minor varieties of less commercial importance. Out of these three species, *M. rosenbergii* has got some distinet advantages to the culturists over the other species.

Scampi seeds are available mainly in four South Bengal districts - 24 Paraganas, Hcoghly, Nadia ahd Midnapore. Some sporadic natural seed resources of scampi in Murshidabad district contiguous to Nadia district in Nowda and Jalangi Blocks have been identified. The main rivers which conrribute to the production are Ichamati, Bhagirathi, Chursi, Kaleghai Silabati Rupnarayan, Subaranarekha, Mundeswari and Dwarakeslver, River Ichamati contributes the largest share followed by Keleghai and Silabati *M. rosenbergii* breeds during December-july in Hooghly estuary with peak breading falling in March-May (Rajalakshmi, 1961, Rao, 1967) whareas *M. malcolmsenii* breeds during May to August. The juveniles come to inland creeks and canals and upper reaches of the tidal zone of the rives along with tides.

Some fishermen co-operatives are actively engaged in the collection of scampi seed - Silabati Fisheries Co-operalive Society, Gangematara Fishermens Co. operative Society and Rupnarayan Fishermens Co-operative Society of Midnapore district and Petrapole Fishermen's Co-operative Society of 24 Paraganas

district are note-worthy (See Annexure). We want to develop this freshwater prawn farming also in our State.

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ANNEXURE

PARTICULARS OF SCAMPI SEED RESOURCES OF THE STATE

Name of the District	Name of the Block	Landing Centre	Operational Mouzas	River Segment	Operational Months
1. Hooghly	Khanakul II	a. Garer ghat b. Bandar ghat c. Thugir ghat	a. Jagatpur b. Ghoradaha c. Dhanyagheri d. Kankan	1. Rupnarayan (25 Km. stretch from river Darakeswar-Silabati Confluence to Pansuli) 2. Mundeswari (10 km. stretch from Pansuli to Sasopota) 3. Dharakeswar (5 km stretch Darakeswar Silabati confluence to West Thankurani chak)	April-June (Juvelines from 9-30mm)
2. 24-Paraganas, Bongaon Baduria Gaighata Basirhat-1	Swarupnagar	a. Swarupnagar b. Petropole c. Baduria d. Gaighata e. Itindaghat	a. Charghat b. Diara c. Tapi d. Kabrapota e. Swarupnagar f. Labangola g. Nakful h. Kakrasuti i. Ranidanga j. Jaleswar k. Gaighata l. Petrapole	I chamati (Jamuna)	June-October (Fingerlings of 4-7, 4-15 cm.)

(*Contd.*)

(1)	(2)	(3)	(4)	(5)	(6)
3. Nadia	chakdaha	Bhagirathi Silpashram Chakdaha	Madanpur Simurali Chaduria	Ganges	April-June (Juveniles 9-4 cm)
	Hanskhali	Benalibazar Hanrikhali HansKhali Bridge Balikamari Manjoan Bapujinagar	Berhanskhali Byospur	Churni (12 km stage between Benali to Mamjoan)	June to September (Juvenile 4.8 cm)
	Krishnaganj.	Krishnaganj	Gobipur	Churni and Mathabhanga (Entire Churni river of Bablaban village and Mathabhanga river bed of Gobipur village).	
	Ranaghat I			Churni (upto Ranaghat) Sporadic availability.	
	Krishnagore I & Chapra.	Nishindapur	Konnagar	Silabati	April-May
Midnapore	Ghatal	Benkerhat	Nisindapur Dhenkirhat	(Streth between Nisindapur to Dhenkirhat)	(fingelings from 9 mm to 30 mm)

(Contd.)

(1)	(2)	(3)	(4)	(5)	(6)
	Narayangarh	Raipur Handlaghat Kanthalialash Ganna Patashpur Rajpur Duriabundh Jalichai.		Keleghai	July-October (fingerlings from 4 cm to 8 cm)
	Potashpur	Dandreipatna Colonda Salmabaj Patharghata Katnadighi		Keleghai and Bagnicanal	July to October (Fingerlings from 4 cm to 8 cm.
	Egra II	Paharpur Canal Balighat		Kaleghai Rosulpur (upstream)	
	Sabang	Trisulabad		Kelghai	
	Bhagawanpur I	Puosi Canal		Puosi Canal	
	Dantan II	Bhasraghat		Subarnarekha	
	Khejuri	Kalinagar		Rosulpur.	

SRIMP AS AN IMPORTANT COMPONENT IN CROP SEQUENCE IN BRACKISHWATER PRODUCTION SYSTEM - OBSERVATION ON SEED AVAILABILITY

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In India an estimated 1.4 million hectare of coastal area with the promise of brackishwater aquaculture is known to exist. Of these, about 25,000 ha in West Bengal, 5,000 ha in Kerala and 5,000 ha in Karnataka are already under traditional farming system. In recent years, much importance has been attached in shrimp farming because of its export potentiality and more attention has been diverted towards intensive feed-based culture system to accelerate the yield to promote export. Even in Bheris and Pokkali fields, traditional systems are gradually replaced by scientific managements involving predators control, selective stocking and feeding. Though such scientific measures are useful to boost up production, the first and foremost consideration to promote shrimp farming in the coutnry is to procure good quality brackishwater shrimp seed of commercial importance, namely *Penaeus monodon* and *Penaeus indicus*. All cultivable brackishwater species of fish and prawns in the country except *Etroplus* spp. are not known to breed in confined waters. Presently a major breakthrough has been achived by Central Inland Fisheries Research Institute at Ennore backwaters, Madras in breeding *P. monodon*. Central Institute of Fisheries Education, Bombay and other privata agencies have also achieved success in breeding commercial prawns in hatchery system and it is expected that in no distant future commercial success in shrimp breeding and seed production will be achieved.

Even when hatchery bred shrimp seed will be available in millions, dependence on natural seed for development of shrimp culture still continue. It is, therefore, necessary to lay more emphasis on seed survey of commercial shrimps as an essential pre-requisite to promote brackishwater shrimp farming.

Seed prospecting

During the last two decades investigations were undertaken to assess brackishwater shrimp and fish seed resources along the east and west coast of the country. Greater emphasis were laid from the Estuarine Section of CIFRI Barrackpore, in prospecting shrimp seed of commercial importance in the interlacing creeks and canals of Hooghly-Matla and Thakuran estuarine systems

along the western fringe areas of Sunderbans in West Bengal which had paved the way in establishing a brackish-water shrimp trade, particularly of *P. monodon* in the State. In the survey, season of availabillty and peak period of abundance of two commercial species i.e. *P. monodon* and *P. indicus* were determined with due consideration of other species of fish and prawns.

Penaeus monodon

Right from West Bengal coast up to the Tamil Nadu coast the seed of *P. monodon* is available. In west coast, however, the availability of seed is scanty and in the coromondel coast the abundance is less. In the Sunderbans plenty of post larvae (12-15mm) occur during March to July with peak abundance in April-May. For the Kalinga coast though the period of seed occurrance is more or less like West Bengal Coast, the peak period of abundance at Rushikulya estuary and Chilka lake are February-March and September respectively. Round the year seed occurs in the Northern circars with peak abundance during September to November and May to June. Some post-larvae were also collected in March and during October to December from the Adayar and Marakanam estuaries.

Penaeus indicus

The period of availability of *P. indicus* seed in coastal West Bengal is mainly from January to September with peak during February to April whereas in Orissa, Andhra and Tamil Nadu coasts the post-larvae are available round the year having the major season for Chilka lake and Rushikula estuary during May-June, for Godavari and Srikakulam districts during September and to some extent during April-June; and for Adayar and Marakanam estuaries during January, March and July to October. Near Puduvypeen in Kerala coast plenty of post-larvae are available but for a short span of period mainly from January to March. From Mandovi estuary in Goa, seed is available during October to May with peak in March.

Mullets

Principal mullet seeds of West Bengal coast belongs to *Liza parsia* occuring round the year with peak in February-April. *L. tade* is available during May to September with peak in May-July. In Kalinga coast and northern circars *L, macrolepis* is the principal species available in addition to *Mugil cephalus* and the peak period of abundance of the species are April-May and January-February respectively. In Kerala coast, the seed of *L. macrolepis* and *Mugil dussumieri* occur round the year and *M. cephalus* during January to April. *M. dussumieri* among mullets of the Mandovi estuary in Goa is obtainable mostly during October to December.

Milkfish

Chanos chanos seed is mostly available in Bahuda estuary in Orissa and Kakinada Bay in Andhra Pradhesh during March to July with peak in April-June. The seed is also available during March to July with peak in April-May in Adayar estuary and almost identical period in Marakanam estuary. Limited quantity of seeds are available along Kerala coast and at Baga in Goa.

Pearl spot

Etroplus suratensis is not available in West Bengal coast but its availability is known from Orissa and Andhra coasts. To a great extent, the seed occur during November to February with peak in December January in the Tamil Nadu coast. Near Cochin bar-mouth the juveniles congregate in large numbers during pre-monsoon and monsoon months and at Mandovi estuary during September to May.

Culture sequence of shrimp in] monoculture and mixed culture with suitable fish components

Based on seasonal seed abundance of important cultivable species of brackishwater shrimp and fishes suitable for mixed culture along with prawns in the east and west coasts of the country, a culture sequence of shrimp round the year both for monoculture and mixed culture, could be formulated for a particular stretch already charted out in respect of availability of commercially important seed. To develop such culture system it is necessary first to devide the coastal areas so far prospected into six stretches *viz.* (i) Sunderban coastal area, West Bengal (Lat 21°30'-22°N); (ii) Kalinga coast, Orissa (Lat 19°-21°30' N); (iii) Nothern Circars, Andhra Pradesh (Lat 16°-19°N); (iv) Coromondel coast, Tamil Nadu (Lat 10°30°-16°N); (v) Malabar coast Kerala (Lat 8°-13°N) and (vi) Konkan coast, Goa (Lat 13°-18°N)

The dominant species of commercial prawn available in the Sunderbans, Kalinga and Nothern Circar coastal areas in the east coast is *P. monodon* though the season of availability of the species in Northern Circars is much later than in Kalinga and Sunderban coastal strcehes- It is possible to harvest two crops of *P. monodon* a year in these three streches. The cropping periods in West Bengal and Orissa are February to June and July to January and in Andhra Pradesh May to September and October to April, The monsoon crop may be partly interfered by the rains, resulting in lower production of shrimp. To control excess algae, *L. parsia* in the first shrimp crop and *L. tade* in the second shrimp crop in West Bengal, *L. macrolepis M. cephalus* for the first shrimp crop and *M. cephalus* for the second shrimp crop ia Orissa; and *M. cephalus, L. macrolepis* for boyth the crops or along with *C, chanos* for the first shrimp crop in Andhra Pradesh may be introduced into the culture operations.

Along Coromondel, Malabar and Konkan coasts, *P. indicus* is the dominant commercial prawn encounted. Culture of *P. indicus* may be done round the year to get 3 crops a year in Tamil Nadu and 2 crops a year in Kerala and Goa coasts, because the third crop in Malabar area and the second crop out of 3 crops in Konkan area cannot be raised for dearth of seed. However, during these fallow months in Kerala and Goa food fishes could be raised instead of shrimp farming.

Based on the seed availability of *P. monodon*, culture of the species in Coromondel coast may be undertaken

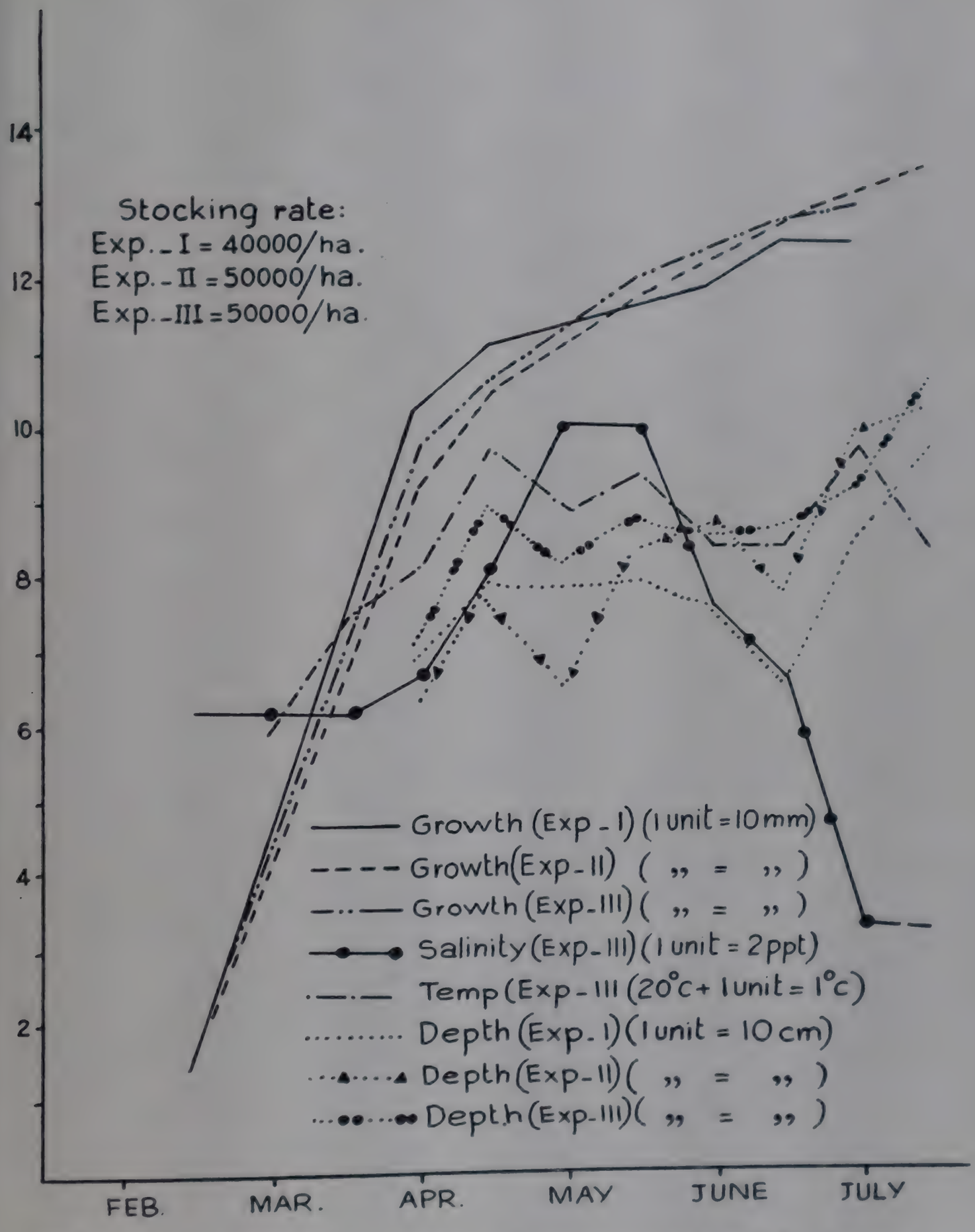


FIG. 1 RELATIONSHIP OF *P. monodon* GROWTH IN

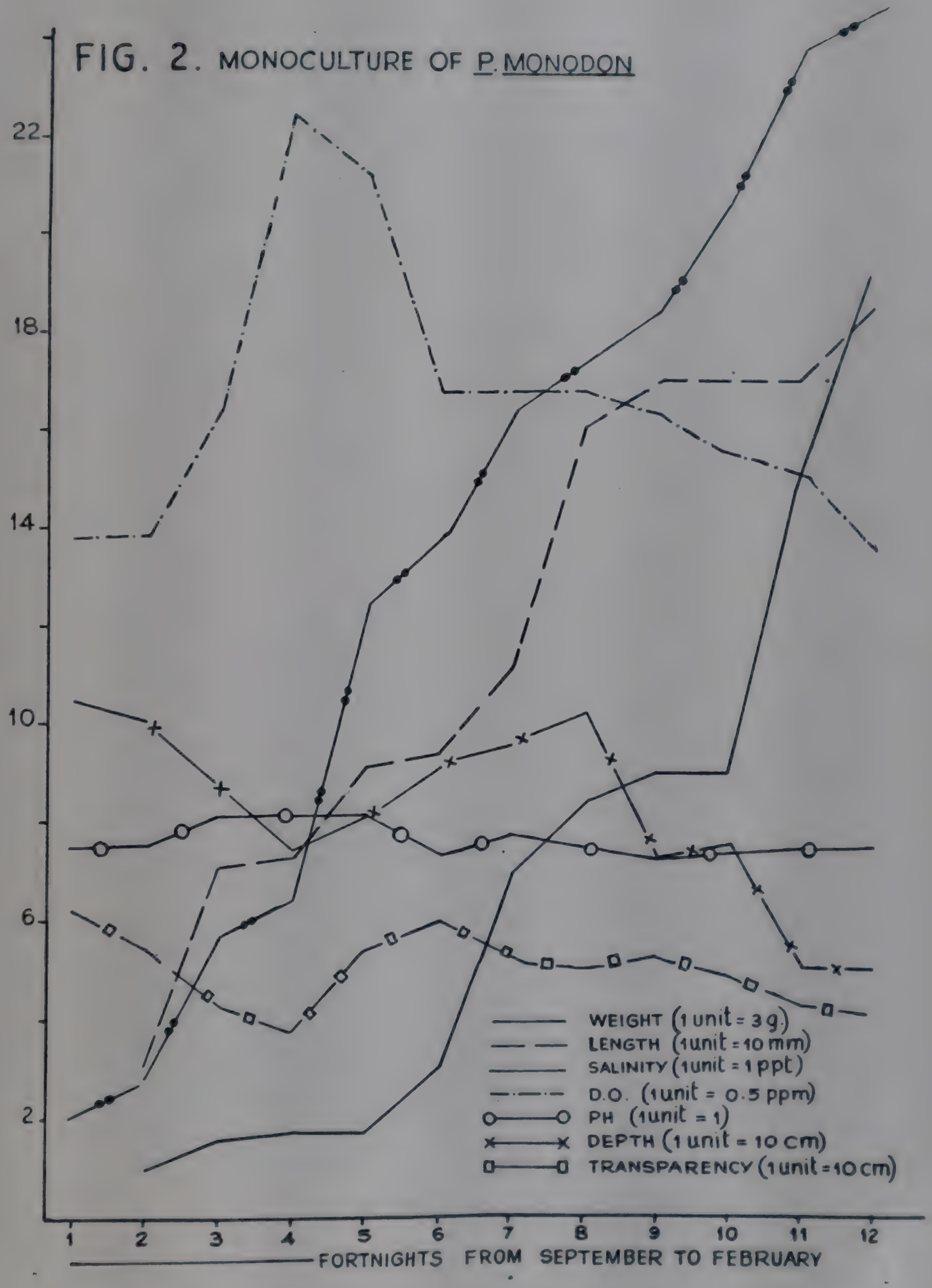
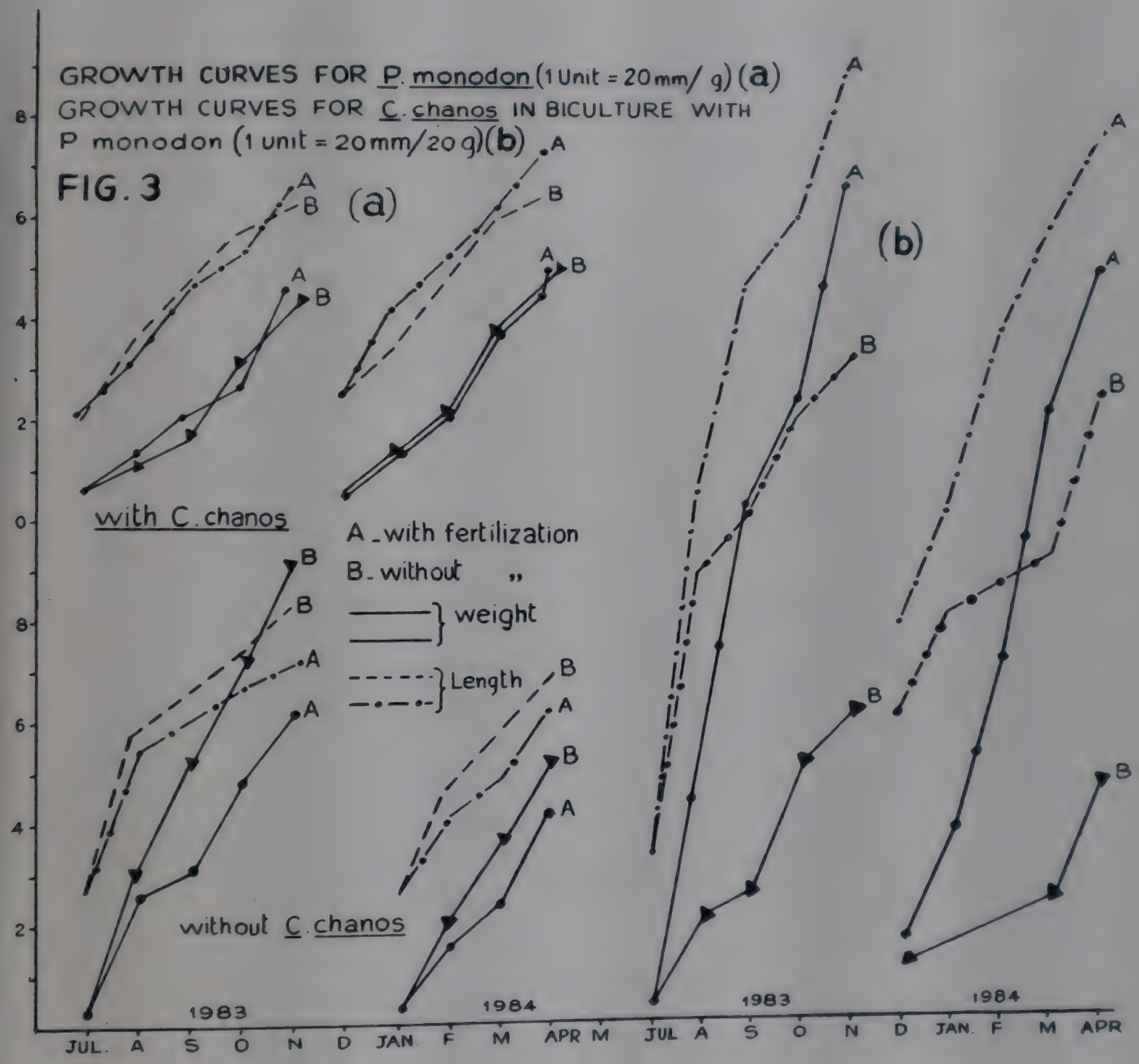


FIG. 2. MONOCULTURE OF P. MONODON
22
18
14
10
6
2
WEIGHT (1 unit = 3 g.)
LENGTH (1 unit = 10 mm)
SALINITY (1 unit = 1 ppt)
D.O. (1 unit = 0.5 ppm)
PH (1 unit = 1)
DEPTH (1 unit = 10 cm)
TRANSPARENCY (1 unit = 10 cm)
1 2 3 4 5 6 7 8 9 10 11 12
FORTNIGHTS FROM SEPTEMBER TO FEBRUARY


GROWTH CURVES FOR P. monodon (1 Unit = 20 mm/ g) (a)
GROWTH CURVES FOR C. chanos IN BICULTURE WITH P monodon (1 unit = 20 mm/ 20 g) (b)
FIG. 3
(a)
(b)
with C. chanos
without C. chanos
A - with fertilization
B - without ,,
weight
Length
1983
1984
JUL. A S O N D JAN. F M APR M

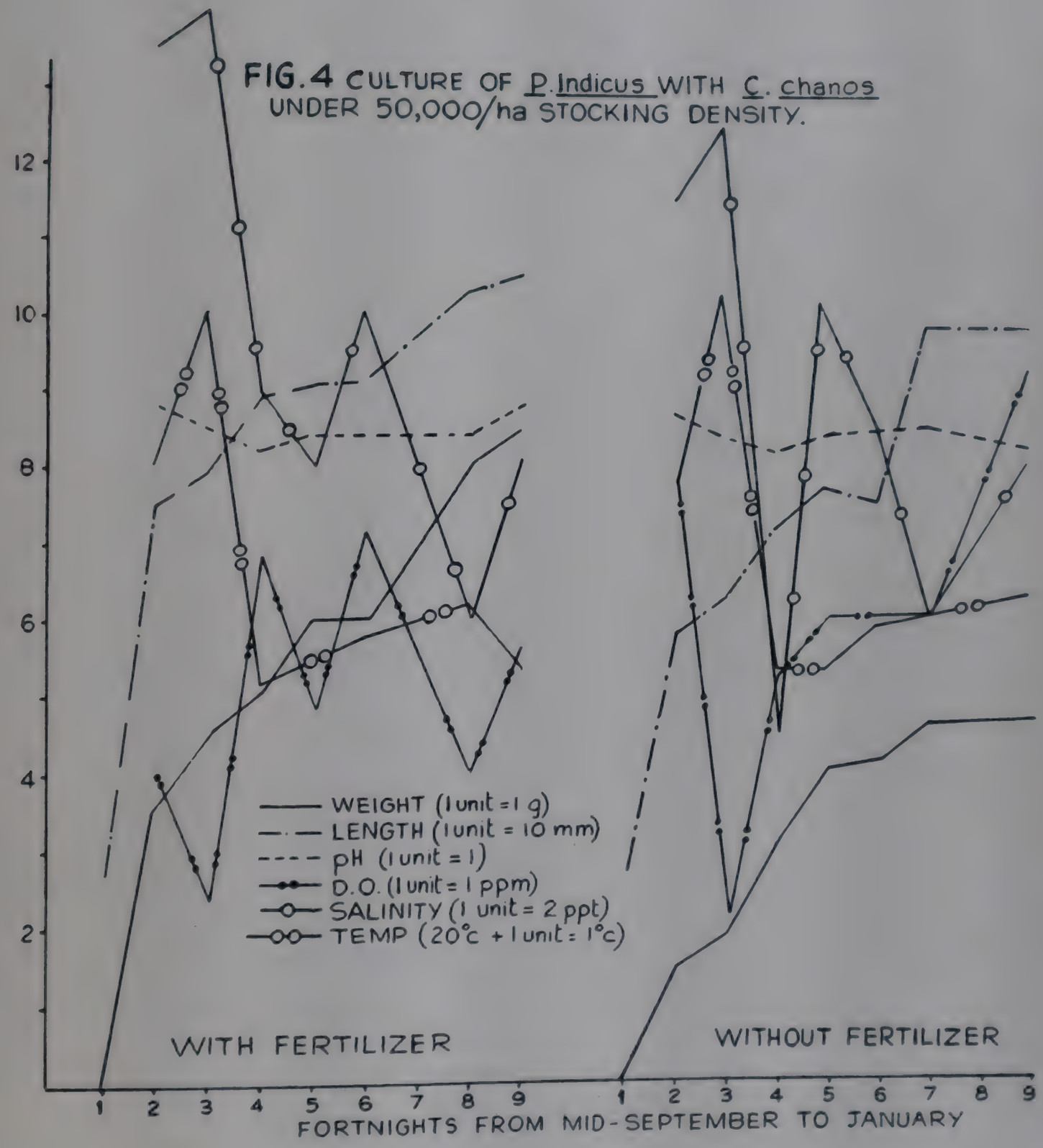


FIG. 4 CULTURE OF P. Indicus WITH C. chanos UNDER 50,000/ha STOCKING DENSITY.
12
10
8
6
4
2
WEIGHT (1 unit = 1 g)
LENGTH (1 unit = 10 mm)
pH (1 unit = 1)
D.O. (1 unit = 1 ppm)
SALINITY (1 unit = 2 ppt)
TEMP (20°C + 1 unit = 1°C)
WITH FERTILIZER
WITHOUT FERTILIZER
1 2 3 4 5 6 7 8 9
1 2 3 4 5 6 7 8 9
FORTNIGHTS FROM MID-SEPTEMBER TO JANUARY

from March to June and again from November to February with a crop of *P. indicns* during July to October in between two crops of *P. monodon*. The cropping periods of *P. indicus* are suggested to be January-March, April-June and July-December in Tamil Nadu; January-March and April-June in Kerala; and March-May and November-February in Goa.

Any excess algal growth can be checked during *P. indicus* culture by introducing mullets, milkfish or pearl spot. In Coromondel coast, *L. macrolepis E. suratensis* for the first shrimp crop, *L. macrolepis C. chanos* for the second and third shrimp crops in Malabar coast *P. macrolepis M. dussumieri M. cephalus* for both the crops and *C. chanos E. suratensis* for the second shrimp crop, and in Konkan coast, *C. chanos* for the first shrimp crop and *M. dussumieri E. suratensis* for the second shrimp crop may be introduced into the culture system (Table-1).

Ecological parameters influencing growth and yield of shrimp

Results of several years reveal that during the rising phases of salinity and temperature in yearly summer, *P. monodon* grows fast (1.25-2.00 mm/day) up to 100-110 mm size and then the growth rate falls (0.25-0.80 mm/day) with the onset of monsoon. However, gradual change in salinity has no adverse effect. At Kakdwip, the growth rate in *P. monodon* retarded slightly with the drop in salinity from 20.2 to 6.2 ppt during monsoon (Fig. 1). Gain in length of *P. monodon* up to 100 mm/7.5g of size is faster and afterwards gain in weight becomes faster till 170mm/40g size is attained, when both, length and weight gains, become steady. At Ela Dauji (Goa) the growth of *P. monodon* depends on the corresponding rise and fall in salinity build up in the ecosystem. No appreciable effect of D. O., pH, temperature, etc. is observed to influence growth increment of *P. monodon* excepting retarded growth during fall in temperature (Fig. 2). The yield of *P. monodon* in fertilized pond at Kakinada is better (540kg/ha/120 days) than in control (186kg/ha/120 days) due to higher growth (Fig. 3). Yield of *P. monodon*, when cultured alone or in combination with fish at Kakinada is better during monsoon rather than in summer. In mono and bicropping culture system, the highest yields of *P. monodon* are 871.75 and 510kg/ha/yr respectively.

It is evident from the culture trails on *P. monodon* that the stocking of post-larvae (10-12mm) @ 50,000/ha. is better than stocking juveniles (23-53mm) @ 15,000/ha. Retrieval after 6 to 7 months rearing is less for post larvae, but the yield is higher (300kg/ha) against 200kg/ha by stocking juveniles.

In *P. monodon* culture the highest yield per crop is 458kg/ha recorded at Madras. At Keshpur, Orissa, survival rate of *P. indicus* has been observed to go down suddenly with the decline in salinity level of the ambient water due to monsoon precipitation. The growth rate in *P. indicus* retards with the fall in dissolved oxygen content of water from 9.4 to 4.8 ppm. The shrimp grows to 11.2 g in fertilised pond compared to 5.4 g in the control pond (Fig.4). At Ela Dauji (Goa), the fall in D.O. from 10.6 to 5.5 ppm also affected the growth rate in *P. indicus*. Effects of other parameters,

like pH, transparency etc. are not pronounced on the growth rate of *P. indicus*.

The traditional system of shrimp farming in vouge in the country to day, is fully dependent on natural seed resourses. But the abundance of most of the cultivable shrimp seed, particulary the important tiger shrimp, is known to fluctuate tremendously due to some biological and natural phenomenon. To facilitate conservation of shrimp seed resources of utmost aquaculture importance suitable management measures may be adopted to reduce trawling pressure in vulnerable areas responsible in lifting brood shrimp stock in large numbers, rational exploitation of seed resources keeping in view the recruitment pattern and controlling environmental degradation add ecological habitat of commercial shrimps.

Table 1: **Shrimp culture sequences in Maritime States**

Sunderban Coast (Lat. 21°30'-22°N)		
Shrimp culture sequence No. (1) (Monoculture 2 crops/yr)	Feb-June *P. monodon* culture	July-January *P. monodon* culture
Shrimp culture sequence No. (2) (Biculture - 2 crops/yr)	Feb-June culture of *P. monodon* + *L. parsia*	July-January culture of *P. monodon* + *L. tade*
Kalinga Coast (Lat. 190°-21°30'N)		
Shrimp culture sequence No. (1) (Monoculture - 2 crops/yr)	Feb-June *P. monodon* culture	July-January *P. mondon* culture
Shrimp culture sequence No. (2) (Biculture - 2 crops/yr)	Feb-June culture of *P. monodon* + *L. Microlanis*	July-January culture of *P. monodon* + *M. cephalus*
Northern Circars (Lat. 16°-19°N)		
Shrimp culture sequence No. (1) (Monoculture - 2 crops/yr)	May-Sept *P. Monodon* culture	Oct-April *P. monodon* culture
Shrimp culture sequence No. (2) (Biculture/Tricultura - 2 crops/yr)	May-Sept culture of *P. monodon* + *C. Chanos*/ *L. macrolelpis*/ *M. cephalus*	Oct-April culture of *P. monodon* + *M. cephalus*/ *L. macrolepis*

Coromandal Coast (Lat. 10,30'-16 ° N)			
Shrimp culture sequence No. (1) (Monoculture, 3crops/yr)	Jan-Mar *P. indicus* culture	Apr-June *P. indicus* culture	July-Dec. *P. indicus* culture
Shrimp culture sequence No. (2) (Biculture/Triculture-3 crops/yr)	Jan-Mar culture of *P. indicus* + *L. macrolepis* / *E. suratensis* or both	Apr-June culture of P. *indicus* + *L. macrolepis*/ *C. Chanos* or both	July-Dec. culture of *P. indicus* + *L. macrolepis*/ *C. chanos* or both
Shrimp culture sequence No. (3) (Monoculture-3 crops/yr	Mar-June *P. monodon* culture	July-Oct. *P. indicus* culture	Nov-Feb. *P. monodon* culture
Malabar Coast (Lat. 8° 13 ° N)			
Shrimp culture sequence No. (1) (Monoculture-2 prawn crop/yr— Mixed culture 1 fish/crop/yr)	Jan-Mar. *P. indicus*	Apr-June *P. indicus*	July-Dec. Follow month for fish culture
Shrimp culture sequence No. (2) (Biculture/Triculture 2) prawn fish crops/yr + Mixed culture 1 fish crop/yr	Jan-Mar. Culture of *P. indicus* + *L. macrolepis*/ *M. cephalus*/, *M. dussumieri*	Apr-June culture of *P. indicus* + *L. macrolepis*/ *M. dussumieri* *M. cephalus* *C. chanos* *E. suratensis*	July-Dec. Follow months for fish culture
Konkan Coast (Lat. 13 ° 18 ° N)			
Shrimp culture sequence No. (1) (Monoculture - 2 prwn crops/yr + Mixed culture 1 fish crop/yr)	Mar-May *P. indicus* culture	Apr-June Follow months for fish culture	July-Dec. *P. indicus* culture
Shrimp culture sequence No. (2) Biculture-2 prawn crops/yr Mixed (culture 1 fish crop/yr)	Mar-May Culture of *P. indicus* + *C. chanos*	June-Oct. Follow months for fish culture	Nov-Feb. culture of *P. indicns* + *M. dussumieri* *E. suratensis*

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